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(54) Title: A PROCESS TO STUDY CHANGES IN GENE EXPRESSION IN GRANULOCYTIC CELLS

(57) Abstract

The present invention comprises a method to identify granulocytic cell genes that are differentially expressed upon exposure to a pathogen or in a sterile inflammatory disease by preparing a gene expression profile of a granulocytic cell population exposed to a pathogen or isolated from a subject having a sterile inflammatory disease and comparing that profile to a profile prepared from quiescent granulocytic cells. The present invention is particularly useful for identifying cytokine genes, genes encoding cell surface receptors and genes encoding intermediary signaling molecules. The invention also includes methods to identify a therapeutic agent that modulates the expression of at least one gene in a granulocyte population. Genes which are differentially expressed during neutrophil contact with a pathogen, such as a virulent bacteria, or that are differentially expressed in a subject having a sterile inflammatory disease are of particular importance.

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**A PROCESS TO STUDY CHANGES IN GENE EXPRESSION IN
GRANULOCYTIC CELLS**

This application is related to application serial No. 08/510,032, serial No. 60/056,844 and application serial No. 08/688,514, all of which are herein incorporated by reference in their entirety. All published articles, patents and other publications cited throughout this application are herein incorporated by reference in their entirety.

5 Technical Field

This invention relates to compositions and methods useful to identify agents that modulate the response of granulocytes to inflammatory and infectious conditions.

Background of the Invention

Granulocytes (*i.e.*, neutrophils, eosinophils and basophils) are involved in the
10 immune response elicited by inflammation and infection.

Inflammation

Inflammation is a localized protective response elicited by injury or destruction of tissues which serves to destroy, dilute or wall off both the injurious agent and the injured tissue. It is characterized by fenestration of the microvasculature, leakages of
15 the elements of blood into the interstitial spaces, and migration of leukocytes into the inflamed tissue. On a macroscopic level, this is usually accompanied by the familiar clinical signs of erythema, edema, tenderness (hyperalgesia), and pain. During this complex response, chemical mediators such as histamine, 5-hydroxytryptamine, various chemotactic factors, bradykinin, leukotrienes, and prostaglandins are released locally.
20 Phagocytic cells migrate into the area, and cellular lysosomal membranes may be ruptured, releasing lytic enzymes. All of these events may contribute to the inflammatory response.

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Inflammation is initiated by, among other things, trauma, tissue necrosis, infection or immune reactions. The immediate response is temporary vasoconstriction. Vasoconstriction is followed within seconds by the acute vascular response resulting in increased blood flow (hyperemia) and edema. The acute phase is also characterized by 5 the margination of polymorphonuclear white blood cells (neutrophils) next to endothelial cells, followed by emigration of neutrophils into the adjacent tissue. Margination is recognized by the lining up of neutrophils along the endothelium of vessels. Emigration occurs by passage of the inflammatory cells between endothelial cells.

10 *Neutrophils*

Neutrophils are the first wave of cellular attack on invading organisms and are the characteristic cells of acute inflammation. The appearance of neutrophils in areas of inflammation may be caused by chemicals released from bacteria, factors produced nonspecifically from necrotic tissue or antibody reacting with antigen. Neutrophils use 15 an actin-rich cytoskeleton to move in a directed manner along a chemotactic gradient from the bloodstream to an inflammatory site where they ingest particles (e.g., bacteria) and immune complexes bearing IgG (via FcR) and/or breakdown products of the complement component C3.

Neutrophils belong to a category of white blood cells known as 20 polymorphonuclear white blood cells. The blood cells with single nuclei (mononuclear cells) form the white blood cell population that includes macrophages, T and B cells. White blood cells that contain segmented nuclei are broadly classified as polymorphonuclear. Polymorphonuclear white blood cells (or "granulocytes") are further subdivided into three major populations on the basis of the staining properties of 25 their cytoplasmic granules in standard hematologic smears or tissue preparations: neutrophils staining pink, eosinophils staining red and basophils staining blue.

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Neutrophils (also referred to as polymorphonuclear neutrophils-PMNs) make up 50% to 70% of the white blood cells (WBCs) of the peripheral blood and may be found scattered diffusely in many tissues, although they are most frequently found in areas of acute inflammation or acute necrosis. Like other WBCs, neutrophils are produced from 5 precursor cells in the bone marrow and released into the blood when mature. After entering the circulation, neutrophils are thought to last only 1 or 2 days.

Neutrophils are characterized by numerous cytoplasmic granules that contain highly destructive enzymes that must be kept isolated from the cytoplasm. These 10 granules contain a number of oxygen-independent enzymes as well as oxygen-dependent mechanisms of killing. Upon attraction to sites of inflammation, neutrophils attempt to engulf and digest bacteria coated with antibody and complement. Phagocytosis by neutrophils is also usually accompanied by release of the lysosomal enzymes into the tissue spaces, particularly if the organism is difficult for the neutrophil to digest

15 At least three cytoplasmic granules are identifiable in neutrophils: specific granules containing lactoferrin, B cytochrome, the complement receptor CR3 and β_2 -integrin; azurophilic granules containing acid hydrolases and other enzymes; and a third granule containing gelatinase.

In addition to the role neutrophils and other granulocytic cells play in immune 20 response to pathogens, including bacterial infection, neutrophils and other granulocytic cells play an unwanted role in many chronic inflammatory diseases. There are many disease states in which excessive or unregulated granulocytic cell infiltration and activation are implicated in exacerbating and/or causing the disease. For instance, many inflammatory diseases are characterized by massive neutrophil infiltration, such as 25 psoriasis, inflammatory bowel disease, Crohn's disease, asthma, cardiac and renal reperfusion injury, adult respiratory distress syndrome, rheumatoid arthritis, thrombosis and glomerulonephritis. All of these diseases are associated with increased IL-8

production which may be responsible for the chemotaxis of neutrophils into the inflammatory site.

While the role of neutrophil infiltration and activation in inflammation is well known, the biosynthetic responses of neutrophils to pathogens, chemotactic agents, 5 proinflammatory molecules, etc. are not as well understood. Neutrophils were once thought to be in a state of terminal differentiation, thereby lacking biosynthetic ability. This view is consistent with the relative scarcity in mature circulating neutrophils of ribosomes and endoplasmic reticulum and with the ability of neutrophils to ingest particles when RNA and/or protein synthesis has been inhibited. More recently it has 10 been demonstrated that neutrophils perform more active roles in their response to environmental stimuli.

It has thus recently been established that neutrophils synthesize *de novo* important macromolecules including, but not limited to interleukin (IL) 1, IL-6, IL-8, tumor necrosis factor (TNF α), granulocyte and macrophage colony-stimulating factors, 15 interferon α (IFN α), intercellular adhesion molecule (ICAM-1) and membrane and cytoskeletal molecules, such as major histocompatibility class I antigens and actin (Beaulieu et al (1992) *J. Biolog. Chem.* 267(1):426-432; Arnold et al. (1993) *Infect. Immun.* 61(6):2545-2552; and Elsner et al. (1995) *Immunobiol* 193:456-464). No study, however, has taken a systematic approach to assess the transcriptional response 20 during neutrophil activation via contact with a pathogen or from neutrophils isolated from a subject with a sterile inflammatory disease.

Eosinophils and Basophils

Eosinophils are another granulocytic or polymorphonuclear white blood cell that are involved in the inflammatory response. Eosinophils are found predominately in 25 two types of inflammation: allergy and parasite infections.

The role of eosinophils in the host response to parasites is thought to be mediated through the components of the eosinophilic granules. Eosinophils are

cytotoxic to schistosome larvae through an antibody-dependent cell-mediated mechanism. Eosinophil cationic proteins are highly toxic for schistosomes and may be responsible for binding of eosinophils to parasitic worms as well as fragmentation of the parasite.

5 The role of eosinophils in acute inflammation is not fully understood. On one hand, there is evidence that enzymes in eosinophils may serve to limit the extent of inflammation by neutralizing mediators of anaphylaxis, such as LTC4, histamine and platelet-activating factor. On the other hand, there is increasing evidence that cationic proteins in eosinophilic granules are mediators of acute inflammation. Eosinophil 10 activation is associated with acute tissue injury and cause an intense vasoconstriction in lung microvasculature, followed by increased pulmonary vascular permeability and pulmonary edema.

Basophils or mast cells are the other major cell type characterized as a granulocytic or polymorphonuclear white blood cell. Mast cells contain granules with a 15 variety of biologically active agents which, when released extracellularly (degranulation), cause dilation of the smooth muscle of arterioles (vasodilation), increased blood flow, and contraction of endothelial cells, thereby opening up vessel walls to permit egress of antibodies, complement or inflammatory cells into tissue spaces.

20 Summary of the Invention

While the role of neutrophils and other granulocytic cells in inflammation and/or the immunological response to infection has been the subject of intense study, little is known about the global transcriptional response of granulocytes during cell activation. The present inventors have devised an approach to systematically assess the 25 transcriptional response from granulocytic cells activated through contact with a pathogen or from granulocytic cells isolated from a subject with a sterile inflammatory disease.

The present invention includes a method to identify granulocytic cell genes that are differentially expressed upon exposure to a pathogen by preparing a gene expression profile of a granulocytic cell population exposed to a pathogen and comparing that profile to a profile prepared from quiescent granulocytic cells. cDNA species, and 5 therefore genes, which are expressed *de novo* upon neutrophil contact with a pathogen are thereby identified. The present invention is particularly useful for identifying cytokine genes, genes encoding cell surface receptors and genes encoding intermediary signaling molecules.

The present invention also includes a method to identify granulocytic cell genes 10 that are differentially expressed in response to a sterile inflammatory disease by preparing a gene expression profile of a granulocytic cell population isolated from a subject exhibiting the symptoms of a sterile inflammatory disease and comparing that profile to a profile prepared from granulocytic cells isolated from a normal granulocytic cell population. cDNA species, and therefore genes, which are differentially expressed 15 in the granulocytic cells of a subject exhibiting the symptoms of a sterile inflammatory disease are thereby identified.

The present invention also includes a method to identify granulocytic cell genes that are differentially expressed upon exposure of a granulocytic cell population to an 20 agonist (pro-inflammatory molecule) by preparing a gene expression profile of a granulocytic cell population contacted with an agonist and comparing that profile to a profile prepared from noncontacted granulocytic cells, thereby identifying cDNA species, and therefore genes, which are expressed *de novo* in the granulocytic cells contacted with the agonist are thereby identified.

The present invention further includes a method to identify a therapeutic or 25 prophylactic agent that modulates the response of a granulocyte population to a pathogen, comprising the steps of preparing a first gene expression profile of a quiescent granulocyte population, preparing a second gene expression profile of a granulocyte population exposed to a pathogen, treating said exposed granulocyte

population with the agent, preparing a third gene expression profile of the treated granulocyte population, comparing the first, second and third gene expression profiles and identifying agents that modulate the response of a granulocyte population to the pathogen.

5 Another aspect of the invention is a method to identify a therapeutic agent that modulates the expression of genes in a granulocyte population found in a subject having Another aspect of the invention includes a method to identify a therapeutic or prophylactic agent that modulates the response of a granulocyte cell population in a subject having a sterile inflammatory disease, comprising the steps of preparing a first 10 gene expression profile of a granulocyte population in a subject having a sterile inflammatory disease, treating the granulocyte population with the agent, preparing a second gene expression profile of the treated granulocyte population, comparing the first and second gene expression profiles with the gene expression profile of a normal granulocyte population and identifying agents that modulate the expression of genes 15 whose transcription levels are altered in the granulocyte population of the subject as compared with normal granulocyte population.

A further aspect of the present invention is a method to identify a therapeutic or prophylactic agent that modulates the response of a granulocytic population to an agonist (pro-inflammatory molecule), comprising the steps of preparing a first gene 20 expression profile of a quiescent granulocyte population, preparing a second gene expression profile of a granulocyte population exposed to an agonist, treating the exposed granulocyte population with the agent, preparing a third gene expression profile of the treated granulocyte population, comparing the first, second and third gene expression profiles and identifying agents that modulate the response of a granulocytic 25 population exposed to an agonist.

The present invention also includes a method of diagnosing the exposure of a subject to a pathogen, comprising the steps of preparing a first gene expression profile of a granulocyte population from the subject, comparing the first gene expression

profile to a second gene expression profile of a granulocyte population exposed to that pathogen and to a third gene expression profile of a normal granulocyte preparation and diagnosing whether the subject has been exposed to a pathogen.

Another aspect of the invention includes a method of diagnosing a sterile inflammatory disease in a subject, comprising the steps of preparing a first gene expression profile of a granulocyte population from the subject, comparing the first gene expression profile to at least one second gene expression profile from a granulocyte population from a subject having a sterile inflammatory disease and to a third gene expression profile of a normal granulocyte preparation and thereby determining if the subject has a sterile inflammatory disease.

The present invention also includes a method of identifying new bacterial virulence factor genes by preparing a first gene expression profile of a quiescent granulocyte population, preparing a second gene expression profile of a granulocyte population exposed to a virulent or avirulent bacterial strain, preparing a third gene expression profile from a granulocyte population exposed to a bacterial strain with a mutation in a putative bacterial virulence factor gene, comparing the first, second and third gene expression profiles and identifying a bacterial virulence factor gene.

Another aspect of the invention is a composition comprising a grouping of nucleic acids that correspond to at least a part of one or more of the genes whose expression levels are modulated in a granulocyte population that has been exposed to a pathogen, these nucleic acids being affixed to a solid support.

Lastly, an aspect of the invention is a composition comprising a grouping of nucleic acids that correspond to at least part of one or more genes whose expression levels are modulated in a granulocyte population found in a subject having a sterile inflammatory disease, these nucleic acids being affixed to a solid support.

Brief Description of the Drawings

Fig. 1 Figure 1 is an autoradiogram of the expression profile generated from cDNAs made with RNA isolated from neutrophils exposed to avirulent *Escherichia coli* and virulent and avirulent *Yersinia pestis*.

Fig. 2 Figure 2 is an autoradiogram of the expression profile generated from 5 cDNAs made with RNA isolated from neutrophils exposed to virulent and avirulent *E. coli*, virulent and avirulent *Y. pestis*, LPS, GM-CSF, TNF α , or γ IFN.

Fig. 3 Figure 3 is an autoradiogram of the expression profile generated from cDNAs made with RNA isolated from neutrophils exposed to avirulent *E. coli* and virulent and avirulent *Y. pestis*. All possible 12 anchoring oligo d(T)n1, n2 were used 10 to generate a complete expression profile for the enzyme *Bgl*II.

Fig. 4 Figure 4 represents a summary of genes which are differentially expressed in neutrophils upon exposure to virulent and avirulent *E. coli* and *Y. pestis*.

Fig. 5 Figure 5 is an autoradiogram of the expression profile generated from cDNAs made with RNA isolated from neutrophils exposed to avirulent *E. coli* and 15 virulent and avirulent *Y. pestis*. All possible 12 anchoring oligo d(T)n1, n2 were used to generate a complete expression profile for the enzyme *Bam*HI.

Fig. 6 is a section of an autoradiogram showing the differences in band intensity for 2 mRNA species when neutrophils are exposed to avirulent *E. coli* and virulent and avirulent *Y. pestis*.

20 Modes of Carrying Out the Invention

General Description

The response of neutrophils to pathogens, including bacterial pathogens, is a subject of primary importance in view of the need to find ways to modulate the immune response to infection. Similarly, the response of neutrophils to agonists (pro-25 inflammatory molecules) is a subject of primary importance in view of the need to find better ways of controlling inflammation in various disease states. One means of assessing the response of neutrophils to pathogens and agonists is to measure the ability

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of neutrophils to synthesize specific RNA *de novo* upon contact with the pathogen or agonist.

The following discussion presents a general description of the invention as well definitions for certain terms used herein.

5 Definitions

Granulocytic cells, also known as polymorphonuclear white blood cells, include neutrophils, also known as polymorphonuclear neutrophils or peripheral blood neutrophils, eosinophils, and basophils, also referred to as mast cells.

The term "pathogen" refers to any infectious organism including bacteria, viruses, parasites, mycoplasma, protozoans, and fungi (including molds and yeast). Pathogenic bacteria include, but are not limited to *Staphylococci* (e.g. *aureus*), *Streptococci* (e.g. *pneumoniae*), *Clostridia* (e.g. *perfringens*), *Neisseria* (e.g. *gonorrhoeae*), *Enterobacteriaceae* (e.g. *coli* as well as *Klebsiella*, *Salmonella*, *Shigella*, *Yersinia* and *Proteus*), *Helicobacter* (e.g. *pylori*), *Vibrio* (e.g. *cholerae*), *Campylobacter* (e.g. *jejuni*), *Pseudomonas* (e.g. *aeruginosa*), *Haemophilus* (e.g. *influenzae*), *Bordetella* (e.g. *pertussis*), *Mycoplasma* (e.g. *pneumoniae*), *Ureaplasma* (e.g. *urealyticum*), *Legionella* (e.g. *pneumophila*), *Spirochetes* (e.g. *Treponema*, *Leptospira* and *Borrelia*), *Mycobacteria* (e.g. *tuberculosis*, *smegmatis*), *Actinomyces* (e.g. *(israelii)*), *Nocardia* (e.g. *asteroides*), *Chlamydia* (e.g. *trachomatis*), *Rickettsia*, *Coxiella*, *Ehrlichia*, *Rochalimaea*, *Brucella*, *Yersinia*, *Fracisella*, and *Pasteurella*.

The term "sterile inflammatory disease" refers to any inflammatory disease caused by immune or nonimmune mechanisms not directly linked to infection (see Stewart *et al.*). Examples of sterile inflammatory diseases include, but are not limited to psoriasis, rheumatoid arthritis, glomerulonephritis, asthma, cardiac and renal reperfusion injury, *thrombosis*, adult respiratory distress syndrome, inflammatory bowel diseases such as *Crohn's disease* and *ulcerative colitis* and periodontal disease.

The phrase "solid support" refers to any support to which nucleic acids can be bound or immobilized, including nitrocellulose, nylon, glass, other solid supports which are positively charged and nanochannel glass arrays disclosed by Beattie (WO 95/1175).

The phrase "gene expression profile", also referred to as a "differential expression profile" or "expression profile" refers to any representation of the expression of at least one mRNA species in a cell sample or population. For instance, a gene expression profile can refer to an autoradiograph of labeled cDNA fragments produced from total cellular mRNA separated on the basis of size by known procedures. Such procedures include slab gel electrophoresis, capillary gene electrophoresis, high performance liquid chromatography, and the like. Digitized representations of scanned electrophoresis gels are also included as are two and three dimensional representations of the digitized data.

While a gene expression profile encompasses a representation of the expression level of at least one mRNA species, in practice, the typical gene expression profile represents the expression level of multiple mRNA species. For instance, a gene expression profile useful in the methods and compositions disclosed herein represents the expression levels of at least about 5, 10, 20, 50, 100, 150, 200, 300, 500, 1000 or more preferably, substantially all of the detectable mRNA species in a cell sample or population.

Particularly preferred are gene expression profiles or arrays affixed to a solid support that contain a sufficient representative number of mRNA species whose expression levels are modulated under the relevant infection, disease, screening, treatment or other experimental conditions. In some instances a sufficient representative number of such mRNA species will be about 1, 2, 5, 10, 15, 20, 25, 30, 40, 50, 50-75 or 100.

Gene expression profiles can be produced by any means known in the art, including, but not limited to the methods disclosed by: Liang *et al.* (1992) *Science* 257:967-971; Ivanova *et al.* (1995) *Nucleic Acids Res.* 23:2954-2958; Guilfoyl *et al.* (1997) *Nucleic Acids Res.* 25(9):1854-1858; Chee *et al.* (1996) *Science* 274:610-614; Velculescu *et al.* (1995) *Science* 270:484-487; Fischer *et al.* (1995) *Proc. Natl. Acad. Sci. USA* 92(12):5331-5335; and Kato (1995) *Nucleic Acids Res.* 23(18):3685-3690. Preferably,

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gene expression profiles are produced by the methods of Prashar *et al.* (WO 97/05286) and Prashar *et al.* (1996) *Proc. Natl. Acad. Sci. USA* 93:659-663.

As an example, gene expression profiles as described herein are made to identify one or more genes whose expression levels are modulated in a granulocytic cell population 5 exposed to a pathogen or isolated from a subject having a sterile inflammatory disease.

The assaying of the modulation of gene expression via the production of a gene expression profile generally involves the production of cDNA from polyA RNA (mRNA) isolated from granulocytes as described below.

The mRNAs are isolated from a granulocytic cell source. The cells may be obtained 10 from an *in vivo* source, such as a peripheral blood. As is apparent to one skilled in the art, any granulocytic cell type may be used, however, neutrophils are preferred.

Furthermore, the peripheral blood cells that are initially obtained may be subjected to various separation techniques (e.g., flow cytometry, density gradients).

mRNAs are isolated from cells by any one of a variety of techniques. Numerous 15 techniques are well known (see e.g., Sambrook *et al.*, *Molecular Cloning: A Laboratory Approach*, Cold Spring harbor Press, NY, 1987; Ausubel et., *Current Protocols in Molecular Biology*, Greene Publishing Co. NY, 1995). In general, these techniques first lyse the cells and then enrich for or purify RNA. In one such protocol. Cells are lysed in a Tris-buffered solution containing SDS. The lysate is extracted with 20 phenol/chloroform, and nucleic acids are precipitated. Purification of poly(A)- containing RNA is not a requirement. The mRNAs may, however, be purified from crude preparations of nucleic acids or from total RNA by chromatography, such as binding and elution from oligo(dT)-cellulose or poly(U)-Sepharose®. As stated above, other protocols and methods for isolation of RNAs may be substituted.

25 The mRNAs are reverse transcribed using an RNA-directed DNA polymerase, such as reverse transcriptase isolated from AMV, MoMuLV or recombinantly produced. Many commercial sources of enzyme are available (e.g., Pharmacia, New England Biolabs, Stratagene Cloning Systems). Suitable buffers, cofactors, and conditions are well

known and supplied by manufacturers (*see also, Sambrook et al., supra; Ausubel et al., supra*).

Various oligonucleotides are used in the production of cDNA. In particular, the methods utilize oligonucleotide primers for cDNA synthesis, adapters, and primers for 5 amplification. Oligonucleotides are generally synthesized as single strands by standard chemistry techniques, including automated synthesis. Oligonucleotides are subsequently de-protected and may be purified by precipitation with ethanol, chromatographed using a sized or reversed-phase column, denaturing polyacrylamide gel electrophoresis, high-pressure liquid chromatography (HPLC), or other suitable 10 method. In addition, within certain preferred embodiments, a functional group, such as biotin, is incorporated preferably at the 5' or 3' terminal nucleotide. A biotinylated oligonucleotide may be synthesized using pre-coupled nucleotides, or alternatively, biotin may be conjugated to the oligonucleotide using standard chemical reactions. Other functional groups, such as fluorescent dyes, radioactive molecules, digoxigenin, 15 and the like, may also be incorporated.

Partially-double stranded adaptors are formed from single stranded oligonucleotides by annealing complementary single-stranded oligonucleotides that are chemically synthesized or by enzymatic synthesis. Following synthesis of each strand, the two oligonucleotide strands are mixed together in a buffered salt solution (e.g., 1 M NaCl, 20 100 mM Tris-HCl pH 8.0, 10 mM EDTA) or in a buffered solution containing Mg²⁺ (e.g., 10 mM MgCl₂) and annealed by heating to high temperature and slow cooling to room temperature.

The oligonucleotide primer that primes first strand DNA synthesis comprises a 5' sequence incapable of hybridizing to a polyA tail of the mRNAs, and a 3' sequence that 25 hybridizes to a portion of the polyA tail of the mRNAs and at least one non-polyA nucleotide immediately upstream of the polyA tail. The 5' sequence is preferably a sufficient length that can serve as a primer for amplification. The 5' sequence also preferably has an average G+C content and does not contain large palindromic

sequence; some palindromes, such as a recognition sequence for a restriction enzyme, may be acceptable. Examples of suitable 5' sequences are

CTCTCAAGGATC:TACCGCT (SEQ ID No. ____),

CAGGGTAGACGACGCTACGC (SEQ ID No. ____), and

5 TAATACCGCGCCACATAGCA (SEQ ID No. ____).

The 5' sequence is joined to a 3' sequence comprising sequence that hybridizes to a portion of the polyA tail of mRNAs and at least one non-polyA nucleotide immediately upstream. Although the polyA-hybridizing sequence is typically a homopolymer of dT or dU, it need only contain a sufficient number of dT or dU bases to hybridize to polyA
10 under the conditions employed. Both oligo-dT and oligo-dU primers have been used and give comparable results. Thus, other bases may be interspersed or concentrated, as long as hybridization is not impeded. Typically, 12 to 18 bases or 12 to 30 bases of dT or dU will be used. However, as one skilled in the art appreciates, the length need only be sufficient to obtain hybridization. The non-polyA nucleotide is A, C, or G, or a
15 nucleotide derivative, such as inosinate. If one non-polyA nucleotide is used, then three oligonucleotide primers are needed to hybridize to all mRNAs. If two non-polyA nucleotides are used, then 12 primers are needed to hybridize to all mRNAs (AA, AC, AG, AT, CA, CC, CG, CT, GA, GC, GG, GT). If three non-poly A nucleotides are used then 48 primers are needed (3 X 4 X 4). Although there is no theoretical upper
20 limit on the number of non-polyA nucleotides, practical considerations make the use of one or two non-polyA nucleotides preferable.

For cDNA synthesis, the mRNAs are either subdivided into three (if one non-polyA nucleotide is used) or 12 (if two non-polyA nucleotides are used) fractions, each containing a single oligonucleotide primer, or the primers may be pooled and contacted
25 with a mRNA preparation. Other subdivisions may alternatively be used. Briefly, first strand cDNA is initiated from the oligonucleotide primer by reverse transcriptase (RTase). As noted above, RTase may be obtained from numerous sources and protocols are well known. Second strand synthesis may be performed by RTase

(Gubler and Hoffman, *Gene* 25: 263, 1983), which also has a DNA-directed DNA polymerase activity, with or without a specific primer, by DNA polymerase 1 in conjunction with RNaseH and DNA ligase, or other equivalent methods. The double-stranded cDNA is generally treated by phenol:chloroform extraction and ethanol 5 precipitation to remove protein and free nucleotides.

Double-stranded cDNA is subsequently digested with an agent that cleaves in a sequence-specific manner. Such cleaving agents include restriction enzymes. Restriction enzyme digestion is preferred; enzymes that are relatively infrequent cutters (e.g., ≥ 5 bp recognition site) are preferred and those that leave overhanging ends are 10 especially preferred. A restriction enzyme with a six base pair recognition site cuts approximately 8% of cDNAs, so that approximately 12 such restriction enzymes should be needed to digest every cDNA at least once. By using 30 restriction enzymes, digestion of every cDNA is assured.

The adapters for use in the present invention are designed such that the two strands 15 are only partially complementary and only one of the nucleic acid strands that the adapter is ligated to can be amplified. Thus, the adapter is partially double-stranded (i.e., comprising two partially hybridized nucleic acid strands), wherein portions of the two strands are non-complementary to each other and portions of the two strands are complementary to each other. Conceptually, the adapter is "Y-shaped" or "bubble-shaped." When the 5' region is non-paired, the 3' end of other strand cannot be 20 extended by a polymerase to make a complementary copy. The ligated adapter can also be blocked at the 3' end to eliminate extension during subsequent amplifications.

Blocking groups include dideoxynucleotides or any other agent capable of blocking the 3'-OH. In this type of adapter ("Y-shaped"), the non-complementary portion of the 25 upper strand of the adapters is preferably a length that can serve as a primer for amplification. As noted above, the non-complementary portion of the lower strand need only be one base, however, a longer sequence is preferable (e.g., 3 to 20 bases; 3 to 15

bases; 5 to 15 bases; or 14 to 24 bases). The complementary portion of the adapter should be long enough to form a duplex under conditions of litigation.

For "bubble-shaped" adapters, the non-complementary portion of the upper strand is preferably a length that can serve as a primer for amplification. Thus, this portion is 5 preferably 15 to 30 bases. Alternatively, the adapter can have a structure similar to the Y-shaped adapter, but has a 3' end that contains a moiety that a DNA polymerase cannot extend from.

Amplification primers are also used in the present invention. Two different amplification steps are performed in the preferred aspect. In the first, the 3' end 10 (referenced to mRNA) of double stranded cDNA that has been cleaved and ligated with an adapter is amplified. For this amplification, either a single primer or a primer pair is used. The sequence of the single primer comprises at least a portion of the 5' sequence of the oligonucleotide primer used for first strand cDNA synthesis. The portion need only be long enough to serve as an amplification primer. The primer pair consists of a 15 first primer whose sequence comprises at least a portion of the 5' sequence of the oligonucleotide primer as described above; and a second primer whose sequence comprises at least a portion of the sequence of one strand of the adapter in the non-complementary portion. The primer will generally contain all the sequence of the non-complementary portion, but may contain less of the sequence, especially when the non- 20 complementary portion is very long, or more of the sequence, especially when the non-complementary portion is very short. In some embodiments, the primer will contain sequence of the complementary portion, as long as that sequence does not appreciably hybridize to the other strand of the adapter under the amplification conditions employed. for example, in one embodiment, the primer sequence comprises four bases 25 of the complementary region to yield a 19 base primer, and amplification cycles are performed at 56°C (annealing temperature), 72°C (extension temperature), and 94°C (denaturation temperature). In another embodiment, the primer is 25 bases long and has 10 bases of sequence in the complementary portion. Amplification cycles for this

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primer are performed at 68°C (annealing and extension temperature) and 94°C (denaturation temperature). By using these longer primers, the specificity of priming is increased.

The design of the amplification primers will generally follow well-known guidelines, 5 such as average G-C content, absence of hairpin structures, inability to form primer-dimers and the like. At times, however, it will be recognized that deviations from such guidelines may be appropriate or desirable.

After amplification, the lengths of the amplified fragments are determined. Any 10 procedure that separate nucleic acids on the basis of size and allows detection or identification of the nucleic acids is acceptable. Such procedures include slab gel electrophoresis, capillary gel electrophoresis, high performance liquid chromatography, and the like.

Electrophoresis is technique based on the mobility of DNA in an electric field.

Negatively charged DNA migrates towards a positive electrode at a rate dependent on 15 their total charge, size, and shape. Most often, DNA is electrophoresed in agarose or polyacrylamide gels. For maximal resolution, polyacrylamide is preferred and for maximal linearity, a denaturant, such as urea is present. A typical gel setup uses a 19:1 mixture of acrylamide:bisacrylamide and a Tris-borate buffer. DNA samples are denatured and applied to the gel, which is usually sandwiched between glass plates. A 20 typical procedure can be found in Sambrook et al (*Molecular Cloning: A Laboratory Approach*, Cold Spring Harbor Press, NY, 1989) or Ausubel et al. (*Current Protocols in Molecular Biology*, Greene Publishing Co., NY, 1995). Variations may be substituted as long as sufficient resolution is obtained.

Capillary electrophoresis (CE) in its various manifestations (free solution, 25 isotachophoresis, isoelectric focusing, polyacrylamide gel, micellar electrokinetic "chromatography") allows high resolution separation of very small sample volumes. Briefly, in capillary electrophoresis, a neutral coated capillary, such as a 50 µm X 37 cm column (eCAP neutral, Beckman Instruments, CA), is filled with a linear

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polyacrylamide (e.g., 0.2% polyacrylamide), a sample is introduced by high-pressure injection followed by an injection of running buffer (e.g., 1X TBE). the sample is electrophoresed and fragments are detected. An order of magnitude increase can be achieved with the use of capillary electrophoresis. Capillaries may be used in parallel

5 for increased throughput (Smith *et al.* (1990) *Nuc. Acids. Res.* 18:4417; Mathies and Huang (1992) *Nature* 359:167). Because of the small sample volume that can be loaded onto a capillary, sample may be concentrated to increase level of detection. One means of concentration is sample stacking (Chien and Burgi (1992) *Anal. Chem* 64:489A). In sample stacking, a large volume of sample in a low concentration buffer is introduced to

10 the capillary column. the capillary is then filled with a buffer of the same composition, but at higher concentration, such that when the sample ions reach the capillary buffer with a lower electric field, they stack into a concentrated zone. Sample stacking can increase detection by one to three orders of magnitude. Other methods of concentration, such as isotachophoresis, may also be used.

15 High-performance liquid chromatography (HPLC) is a chromatographic separation technique that separates compounds in solution. HPLC instruments consist of a reservoir of mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by injecting an aliquot of the sample mixture onto the column. The different components in the mixture pass through the column at different

20 rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase. IP-RO-HPLC on non-porous PS/DVB particles with chemically bonded alkyl chains can also be used to analyze nucleic acid molecules on the basis of size (Huber *et al.* (1993) *Anal. Biochem.* 121:351; Huber *et al.* (1993) *Nuc. Acids Res.* 21:1061; Huber *et al.* (1993) *Biotechniques* 16:898).

25 In each of these analysis techniques, the amplified fragments are detected. A variety of labels can be used to assist in detection. Such labels include, but are not limited to, radioactive molecules (e.g., ³⁵S, ³²P, ³³P) fluorescent molecules, and mass spectrometric

tags. The labels may be attached to the oligonucleotide primers or to nucleotides that are incorporated during DNA synthesis, including amplification.

Radioactive nucleotides may be obtained from commercial sources; radioactive primers may be readily generated by transfer of label from γ -³²P-ATP to a 5'-OH group 5 by a kinase (e.g., T4 polynucleotide kinase). Detection systems include autoradiograph, phosphor image analysis and the like.

Fluorescent nucleotides may be obtained from commercial sources (e.g., ABI, Foster city, CA) or generated by chemical reaction using appropriately derivatized dyes.

Oligonucleotide primers can be labeled, for example, using succinimidyl esters to 10 conjugate to amine-modified oligonucleotides. A variety of fluorescent dyes may be used, including 6 carboxyfluorescein, other carboxyfluorescein derivatives, carboxyrhodamine derivatives, Texas red derivatives, and the like. Detection systems include photomultiplier tubes with appropriate wave-length filters for the dyes used. 15 DNA sequence analysis systems, such as produced by ABI (Foster City, CA), may be used.

After separation of the amplified cDNA fragments, cDNA fragments which correspond to differentially expressed mRNA species are isolated, reamplified and sequenced according to standard procedures. For instance, bands corresponding the 20 cDNA fragments can be cut from the electrophoresis gel, reamplified and subcloned into any available vector, including pCRscript using the PCR script cloning kit (Stratagene). The insert is then sequenced using standard procedures, such as cycle sequencing on an ABI sequencer.

An additional means of analysis comprises hybridization of the amplified fragments to one or more sets of oligonucleotides immobilized on a solid substrate. Historically, the 25 solid substrate is a membrane, such as nitrocellulose or nylon. More recently, the substrate is a silicon wafer or a borosilicate slide. The substrate may be porous (Beattie *et al.* WO 95/11755) or solid. Oligonucleotides are synthesized *in situ* or synthesized prior to deposition on the substrate. Various chemistries are known for attaching

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oligonucleotide. Many of these attachment chemistries rely upon functionalizing oligonucleotides to contain a primary amine group. The oligonucleotides are arranged in an array form, such that the position of each oligonucleotide sequence can be determined.

5 The amplified fragments, which are generally labeled according to one of the methods described herein, are denatured and applied to the oligonucleotides on the substrate under appropriate salt and temperature conditions. In certain embodiments, the conditions are chosen to favor hybridization of exact complementary matches and disfavor hybridization of mismatches. Unhybridized nucleic acids are washed off and
10 10 the hybridized molecules detected, generally both for position and quantity. The detection method will depend upon the label used. Radioactive labels, fluorescent labels and mass spectrometry label are among the suitable labels.

The present invention as set forth in the specific embodiments, includes methods to identify a therapeutic agent that modulates the expression of at least one gene in a
15 15 granulocyte population. Genes which are differentially expressed during neutrophil contact with a pathogen, such as a virulent bacteria, or that are differentially expressed in a subject having a sterile inflammatory disease are of particular importance.

In general, the method to identify a therapeutic or prophylactic agent that modulates the response of a granulocyte population to a pathogen, comprises the steps of preparing
20 20 a first gene expression profile of a quiescent granulocyte population, preparing a second gene expression profile of a granulocyte population exposed to a pathogen, treating the exposed granulocyte population with the agent, preparing a third gene expression profile of the treated granulocyte population, comparing the first, second and third gene expression profiles and identifying agents that modulate the response of a granulocytic
25 25 population to the pathogen.

In another format, the method is used to identify a therapeutic agent that modulates the expression of genes in a granulocyte population found in a subject having a sterile inflammatory disease. The general method comprises the steps of preparing a first gene

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expression profile of a granulocyte population in a subject having a sterile inflammatory disease, treating the granulocyte population with the agent, preparing a second gene expression profile of the treated granulocyte population, comparing the first and second gene expression profile with the gene expression profile of a normal granulocyte

5 preparation and identifying agents that modulate the expression of genes whose transcription levels are altered in the granulocyte population of the subject as compared with normal granulocyte population.

While the above methods for identifying a therapeutic agent comprise the comparison of gene expression profiles from treated and not-treated granulocytic cells, many other 10 variations are immediately envisioned by one of ordinary skill in the art. As an example, as a variation of a method to identify a therapeutic or prophylactic agent that modulates the response of a granulocytic population to a pathogen, the second gene expression profile of a granulocyte population exposed to a pathogen and the third gene expression profile of the treated granulocyte population can each be independently 15 normalized using the first gene expression profile prepared from a quiescent granulocyte population. Normalization of the profiles can easily be achieved by scanning autoradiographs corresponding to each profile, and subtracting the digitized values corresponding to each band on the autoradiograph from quiescent granulocytic cells from the digitized value for each corresponding band on autoradiographs 20 corresponding to the second and third gene expression profiles. After normalization, the second and third gene expression profiles can be compared directly to detect cDNA fragments which correspond to mRNA species which are differentially expressed upon exposure of the granulocyte population to the agent to be tested.

Specific Embodiments

25 Example 1

Production of gene expression profiles generated from cDNAs made with RNA isolated from neutrophils exposed to virulent and avirulent bacteria.

Expression profiles of RNA expression levels from neutrophils exposed to various bacteria offer a powerful means of identifying genes that are specifically regulated in response to bacterial infection. As an example, the production of expression profiles from neutrophils exposed to virulent and avirulent *E. coli* and *Y. pestis* allow the 5 identification of neutrophil genes that are specifically regulated in response to bacterial infection.

Neutrophils were isolated from normal donor peripheral blood following the LPS-free method. Peripheral blood was isolated using a butterfly needle and a syringe containing 5 cc ACD, 5 cc of 6% Dextran (in normal saline). After 30 minutes of 10 settling, plasma was collected and HBSS (without Ca⁺⁺ or Mg⁺⁺) was added to a total volume of 40 ml. The plasma was centrifuged (1500 rpm, for 15 m at 4°C), the supernatant decanted and cold HBSS added to resuspend the cells. The cell suspension was then layered onto a cold Ficoll Hypaque, centrifuged at 500xg for 30m at 4°C. The pellet contains polymorphonuclear neutrophils. Neutrophils can also be isolated by 15 other commonly used methods such as those disclosed in *Current Protocols of Immunology* (John Wiley & Sons, Inc.), Babior *et al.* (1981) In: *Leukocyte Function*, Cline, M.J. Ed., p.1-38 (Church Livingstone, NY), and Haslett *et al.* (1985) *Am. J. Pathol.* 119:101-110.

Following isolation, neutrophils were incubated with *E. coli* or *Y. pestis*. Before 20 incubation, bacteria are harvested and washed in phosphate buffered saline and opsonized either autologous human serum or complement factor C7 deficient human serum (SIGMA). Incubation was at a ratio of approximately a PMN:bacteria ratio of 1:20 in RPMI 1640 (HEPES buffered) with heat inactivated Fetal Bovine Serum at 37°C with gentle mixing in a rotary shaker bath

25 As controls, neutrophils were incubated with either bacterial lipopolysaccharide (LPS) or latex beads. LPS was added to approximately 3.38×10^8 cells in 100 ml of RPMI containing 6% autologous serum to a final concentration of 1 ng/ml to 1 µg/l. Incubation proceeded for 30 or 120 minutes with gentle rotation in disposable

polycarbonate Erlenmeyer flasks at 37°C. After incubation, the cells were spun down and washed once with HBSS.

Total cellular RNA was prepared from untreated and treated neutrophils are described above using the procedure of Newburger *et al.* (1981) *J. Biol. Chem.* 266(24): 5 16171-7 and Newburger *et al.* (1988) *Proc. Natl. Acad. Sci. USA* 85:5215-5219. Ten micrograms of total RNA, the amount obtainable from about 3×10^6 neutrophils, is sufficient for a complete set of cDNA expression profiles.

Synthesis of cDNA was performed as previously described by Prashar *et al.* in WO 97/05286 and in Prashar *et al.* (1996) *Proc. Natl. Acad. Sci. USA* 93:659-663. Briefly, 10 cDNA was synthesized according to the protocol described in the GIBCO/BRL kit for cDNA synthesis. The reaction mixture for first-strand synthesis included 6 μ g of total RNA, and 200 ng of a mixture of 1-base anchored oligo(dT) primers with all three possible anchored bases
(ACGTAATACGACTCACTATAGGGCGAATTGGGTCGACTTTTTTTTTTT
15 TTn1 wherein n1=A/C or G) along with other components for first-strand synthesis reaction except reverse transcriptase. This mixture was incubated at 65°C for 5m, chilled on ice and the process repeated. Alternatively, the reaction mixture may include 10 μ g of total RNA, and 2 pmol of 1 of the 2-base anchored oligo(dT) primers a heel such as RP5.0 (CTCTCAAAGGATCTTACCGCTT₁₈AT), or
20 RP6.0 (TAATACCGCGCCACATAGCAT₁₈CG), or RP9.2 (CAGGGTAGACGACGCTACGCT₁₈GA) along with other components for first-strand synthesis reaction except reverse transcriptase. This mixture was then layered with mineral oil and incubated at 65°C for 7 min followed by 50°C for another 7 min. At this stage, 2 μ l of Superscript reverse transcriptase (200 units/ μ l; GIBCO/BRL) was 25 added quickly and mixed, and the reaction continued for 1 hr at 45-50°C. Second-strand synthesis was performed at 16°C for 2 hr. At the end of the reaction, the cDNAs were precipitated with ethanol and the yield of cDNA was calculated. In our experiments, \approx 200 ng of cDNA was obtained from 10 μ g of total RNA.

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The adapter oligonucleotide sequences were
A1 (TAGCGTCCGGCGCAGCGACGGCCAG) and
A2 (GATCCTGGCCGTCGGCTGTCTGTCGGCGC). One microgram of
oligonucleotide A2 was first phosphorylated at the 5' end using T4 polynucleotide
5 kinase (PNK). After phosphorylation, PNK was heated denatured, and 1 μ g of the
oligonucleotide A1 was added along with 10 \times annealing buffer (1 M NaCl/100 mM
Tris-HCl, pH 8.0/10 mM EDTA, pH 8.0) in a final vol of 20 μ l. This mixture was then
heated at 65°C for 10 min followed by slow cooling to room temperature for 30 min,
resulting in formation of the Y adapter at a final concentration of 100 ng/ μ l. About 20
10 ng of the cDNA was digested with 4 units of *Bgl* II in a final vol of 10 μ l for 30 min at
37°C. Two microliters (\approx 4 ng of digested cDNA) of this reaction mixture was then
used for ligation to 100 ng (\approx 50-fold) of the Y-shaped adapter in a final vol of 5 μ l for
16 hr at 15°C. After ligation, the reaction mixture was diluted with water to a final vol
of 80 μ l (adapter ligated cDNA concentration, \approx 50 pg/ μ l) and heated at 65°C for 10
15 min to denature T4 DNA ligase, and 2- μ l aliquots (with \approx 100 pg of cDNA) were used
for PCR.

The following sets of primers were used for PCR amplification of the adapter
ligated 3' -end cDNAs:

TGAAGCCGAGACGTGGTCG(T)₁₈ n1, n2 (wherein n1, n2 = AA, AC, AG AT
20 CA CC CG CT GA GC GG and GT) as the 3' primer with A1 as the 5' primer or
alternatively
RP 5.0, RP 6.0, or RP 9.2 used as 3' primers with primer A1.1 serving as the 5' primer.
To detect the PCR products on the display gel, 24 pmol of oligonucleotide A1 or A1.1
was 5' -end-labeled using 15 μ l of [γ -³²P]ATP (Amersham; 3000 Ci/mmol) and PNK
25 in a final volume of 20 μ l for 30 min at 37°C. After heat denaturing PNK at 65°C for
20 min, the labeled oligonucleotide was diluted to a final concentration of 2 μ M in 80
 μ l with unlabeled oligonucleotide A1.1. The PCR mixture (20 μ l) consisted of 2 μ l
(\approx 100 pg) of the template, 2 μ l of 10 \times PCR buffer (100 mM Tris-HCl, pH 8.3/500 mM

KCl), 2 μ l of 15 mM MgCl₂ to yield 1.5 mM final Mg²⁺ concentration optimum in the reaction mixture, 200 μ M dNTPs, 200 nM each 5' and 3' PCR primers, and 1 unit of AmpliTaq Gold. Primers and dNTPs were added after preheating the reaction mixture containing the rest of the components at 85 °C. This "hot start" PCR was done to avoid 5 artefactual amplification arising out of arbitrary annealing of PCR primers at lower temperature during transition from room temperature to 94 °C in the first PCR cycle. PCR consisted of 5 cycles of 94 °C for 30 sec, 55 °C for 2 min, and 72 °C for 60 sec followed by 25 cycles of 94 °C for 30 sec, 60 °C for 2 min, and 72 °C for 60 sec. A higher number of cycles resulted in smearable gel patterns. PCR products (2.5 μ l) were 10 analyzed on 6% polyacrylamide sequencing gel. For double or multiple digestion following adapter ligation, 13.2 μ l of the ligated cDNA sample was digested with a secondary restriction enzyme(s) in a final vol of 20 μ l. From this solution, 3 μ l was used as template for PCR. This template vol of 3 μ l carried \approx 100 pg of the cDNA and 15 10 mM MgCl₂ (from the 10 \times enzyme buffer), which diluted to the optimum of 1.5 mM in the final PCR vol of 20 μ l. Since Mg²⁺ comes from the restriction enzyme buffer, it was not included in the reaction mixture when amplifying secondarily cut cDNA. Bands were extracted from the display gels as described by Liang *et al.* (1995 *Curr. Opin. Immunol.* 7:274-280), reamplified using the 5' and 3' primers, and subcloned into pCR-Script with high efficiency using the PCR-Script cloning kit from Stratagene. 20 Plasmids were sequenced by cycle sequencing on an ABI automated sequencer.

Figure 1 presents an autoradiogram of the expression profile generated from cDNAs made from RNA isolated from control (untreated) neutrophils (lanes 1, 5, 10, 13, 14 and 16), neutrophils incubated with avirulent *E. coli* K12 (lanes 2 and 11), virulent *Y. pestis* (lane 3), avirulent *Y. pestis* (lane 4), *Y. pestis* *yopB* (lane 6), *Y. pestis* *yopE* (lane 7), *Y. pestis* *yopH* (lane 8), latex beads (lanes 9 and 19), virulent Enteroto Hemorrhagic *E. coli* (EHEC) (lane 12), LPS (lane 15), 1 ng/ml LPS for 30 minutes (lane 17), and LPS for 120 minutes (lane 18). The anchoring oligo d(T)18 n1, n2 has A and C at the n1 and n2 positions, respectively. The cDNAs were digested with *Bg*II.

Example 2

Production of gene expression profiles generated from cDNAs made with RNA isolated from neutrophils exposed to virulent and avirulent bacteria and neutrophils exposed to cytokines.

5 Neutrophils were isolated from normal donor peripheral blood following the LPS-free method as set forth in Example 1.

Neutrophils were incubated with virulent and avirulent *E. coli* or *Y. pestis*, LPS at 1ng/ml, GM-CSF at 100 units/ml, TNF α at 1000 units/ml, or γ IFN at 100 units/ml.

10 The bacterial cells, LPS or cytokines were added to approximately 3.38×10^8 cells in 100 ml of RPMI containing 6% H1 autologous serum. Incubation proceeded for 2 to 4 hours, preferably 2 hours, with gentle rotation in disposable polycarbonate Erlenmeyer flasks at 37°C. After incubation, the cells were spun down and washed once with HBSS.

15 After incubation of the neutrophils, RNA was extracted and the cDNA profiles prepared as described in Example 1. Figure 2 is an autoradiogram of the expression profiles generated from cDNAs made with RNA isolated from control (untreated) neutrophils (lanes 1, 5, 10 and 14), neutrophils incubated with avirulent *E. coli* K12 (lanes 2 and 11), virulent *Y. pestis* (lanes 3 and 12), avirulent *Y. pestis* (lanes 4 and 13), 1ng/ml LPS (lanes 6 and 15), 100 units/ml GM-CSF(lanes 7 and 16), 1000 units/ml 20 TNF α (lanes 8 and 17) and 100 units/ml γ IFN (lanes 9 and 18). The anchoring oligo d(T)18n1, n2 has A and C at the n1 and n2 positions for lanes 1-9 and G and G at the n1 and n2 for lanes 10-18. The cDNAs were digested with *Bg*II.

25 As exhibited by Figure 2, the differential expression of mRNA species (as exhibited by cDNA fragments) in neutrophils exposed to virulent and avirulent *E. coli* and *Y. pestis* is not equivalent to the differential expression of mRNA species in neutrophils exposed to the various cytokines.

Example 3

Production of gene expression profiles generated from cDNAs made with RNA isolated from neutrophils exposed to bacteria using all 12 possible anchoring oligo d(T) n1,n2.

Neutrophils were isolated from normal donor peripheral blood following the LPS-free method.

5 Neutrophils were incubated with *E. coli* or *Y. pestis*.

After incubation of the neutrophils, RNA was extracted and the cDNA profiles prepared as described in Example 1. Figure 3 is an autoradiogram of the expression profiles generated from cDNAs made with RNA isolated from control (untreated) neutrophils (lane 1), neutrophils incubated with avirulent *E. coli* K12 (lane 2), virulent 10 *Y. pestis* (lane 3), avirulent *Y. pestis* (lane 4). The anchoring oligo d(T)18 n1 and n2 positions are indicated at the top of the figure. The cDNAs were digested with *Bg*II.

Figure 4 represents a summary of genes which are differentially expressed in neutrophils upon exposure to virulent and avirulent *E. coli* and *Y. pestis*. Expression patterns are determined by visual examination of the autoradiography gels comparing 15 band intensity between neutrophils exposed to the various bacteria. The autoradiography gels can also be scanned using commonly available equipment, such as a UMAX D-1L scanner. Bands which exhibit altered intensities in gene expression profiles from neutrophils exposed to the various bacteria when compared to the gene expression profile prepared from normal nonexposed neutrophils are then extracted 20 from the display gel as previously described by in Example 1. The isolated fragments are then reamplified using 5' and 3' primers, subcloned into pCR-Script (Stratagene) and sequenced using an ABI automated sequencer.

Tables 1 and 2 represent a summary of cDNA bands which are differentially expressed in response to exposure to *E. coli*.

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
846	Up	0	0	+-	2+	4+	AA	Yale	K02286	Urokinase Gene
847	Up	+-	+-	+-	+	2-3+	AA	Yale		
848	Up	+-	+-	0	+-	2+	AA	Yale		
849	Up	+-	+-	+-	+-	1-2+	AA	Yale		
850	Down	+	0	0	0	0	AA	Yale		
851	Up	0	0	0	0	+	AA	Yale		
852	Down	+	+	+-	+	0	AA	Yale		
853	Up	0	0	+-	+-	1-2+	AA	Yale		
854	Down	2+	+	+-	0	0	+-	AA	Yale	AF039715 C. elegans cosmid R06A10
T103	Up	3+	3+	3-4+	4-5+	4-5+	AA	Yale	M77693	HUMAN SSAT
855	Up	+-	+-	+-	+-	2+	AA	Yale	G29248	Human STS SHGC 17036
856	Up	+-	+-	+-	+-	2+	AA	Yale	AI038932	ox96ho8.x I soares senescent Fibroblasts
T104	Up	+	+	+-	+	2+	AA	Yale	AA931109	HUMAN CGAP KID3
T105		3-4+	3-4+	3-4+	3+	3+	AA	Yale	M11354	HUMAN H3.3 HISTONE
857		+	+	2+	+	+-	AA	Yale		
T107	Down	2-3+	2-3+	2-3+	2-3+	2+	AA	Yale	AA936257	on43e12 Sinel CGAP c08
858	Down	2+	2+	2+	2+	+-	AA	Yale		
859	Up	+-	+-	+-	2+	1-2+	AA	Yale	AC004987	DJ1173I2 10 Clone
860	Down	2-3+	2-3+	2+	2+	+-	AA	Yale		
861	Down	+	+	1-2+	+-	+-	AA	Yale		
862		2-3+	2-3+	2-3+	2-3+	2-3+	AA	Yale		
863	Down	2+	+	+-	+	+	AA	Yale	H26311	Cystic Fibrosis Antigen
864	Up	2+	2+	2+	2-3+	2-3+	AA	Yale		
865	Up	+	+	2+	2-3+	2+	AA	Yale		

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
866	Up	+-	+-	+	+	2+	AA	Yale	G06511	Human STS WI - 7311
867	Down	2+	2+	2+	2+	1-2+	AA	Yale		
868		+-	+-	+	2+	+-	AA	Yale		
869	Up	+	+-	+-	+-	2+	AC	Yale		
870	Up	0	0	0	+-	1-2+	AC	Yale		
871	Down	1-2+	1-2+	1-2+	+	+-	AC	Yale	AI026899	ov42do7.x I Soares testis nht
872		+	+	+-	+	+	AC	Yale	AA916304	on22do4.s i NCI CGAP Lu5
873	Up	+-_+	+-_+	+-_+	+-_+	2+	IAC	Yale		
874	Up	1-2+	1-2+	1-2+	+	3+	AC	Yale	AI012139	EST 206590 (Rat Placenta)
875	Up	1-2+	1-2+	+	+	2-3+	AC	Yale		
876	Down	+	1-2+	2+	+	+-_0	AC	Yale	AI031728	ow39a05. xI Soares parathyroid tumor NGHPA
877	Down	2-3+	2+	2+	+	+-	AC	Yale		
878	Down	2-3+	2-3+	2+	1-2+	0_+-	AC	Yale	AB002384	human mRNA for KIAA0386 gene
879		+	+-	0	0	+	AC	Yale		
880	Down	1-2+	+-	+-	+-	0	AC	Yale	AI016473	Transcription Factor BTF3
881	Down	+	+	1-2+	+	+-	AC	Yale	U82275	Human immunoglobulin-like transcript
882	Up	2+	2+	3+	3-4+	4+	AC	Yale	AI016664	Diamineacetyl Transferase

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
883	Down	1-2+	+	+	+	+-	AC	Yale	AA909168	.SI Soares NFLT GBC.SI
884	Down	+	+-	0	0	0	AC	Yale	AI039973	ox88e09.s i Soares senescent fibroblasts
885	Up	2+	1-2+	1-2+	2+	2-3+	AC	Yale	AI026998	ow41d06. si Soares parathyroid tumor NB4PA
886		0	+-	+-	+-	0	AC	Yale		
887	Up	+-	0	0	+-	+	AC	Yale		
888	Up	0	0	0	+-	+	AC	Yale		
T7	Down	2+	1-2+	1-2+	+	+-	AC	Yale		
889	Up	+-	0	+-	+-	1-2+	AC	Yale		
T8	Down	2-3+	2+	2+	2+	1-2+	AC	Yale	G06680	HUMAN STS
890	Up	2+	2+	1-2+	+	+-	AC	Yale		
891	Down	+	+	+-	0	0	AC	Yale		
T76	Down	2-3+	2+	2+	1-2+	+-	AC	Yale	S73591	HUMAN H HCPA78 HOMOLOG
892	Down	3+	3+	3+	2+	+-	AC	Yale		
893		2+	+	1-2+	2+	2+	AC	Yale		
T98	Down	2-3+	2-3+	2-3+	2-3+	+-	AC	Yale	G06788	HUMAN STS
894	Down	2+	1-2+	1-2+	1-2+	+	AC	Yale	AF039656	Neuronal tissue-enriched acidic protein
895	Down	2-3+	2-3+	2-3+	2+	+-	AC	Yale	AI016303	ot72d07.si soares total Fetus Nb3hf8
896	Down	2+	2+	1-2+	+-	0	AC	Yale	AC004987	DJ 1173I20 clone

Clones	mRNA Expression Patt m	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
T81	Up	0	0	0	0	3+	AC	Yale	AA926999	om26do7 si Soares NFLTG3c 1s1
T82	Up	+	+	+	+-	2-3+	AC	Yale	AA926999	om26do7 .SI NFL TG3cSi
T83	Down	2+	2+	1-2+	1-2+	1-2+	AC	Yale		
T84		2-3+	2+	2-3+	3+	2-3+	AC	Yale		
T85	Down	+	+-	+-_0	+-_0	0	AC	Yale	O89052	HUMAN PROTON-ATPASE
897	Down	2+	1-2+	1-2+	+	+-	AC	Yale		
898		2+	2+	2+	2+	2+	AC	Yale		
899	Up	0	0	+-	+	3+	AC	Yale		
900	Down		1-2+	1-2+	+-	1-2+	0	AC	Yale	
901	Up		1-2+	+	1-2+	2+	2-3+	AC	Yale	
902	Down		2+	+	1-2+	1-2+	+	AC	Yale	
903	Down		2+	2+	3+	3-4+	+-	AC	Yale	
904			+	+	+-	+-	+	AC	Yale	
905	Up	0	+-	0	+	3-4+	AG	Yale	KO2286	Human urokinase gene 3' end
906	Up	0	0	+-	+-	1-2+	AG	Yale		
T111		+-_+	2+	+-	+-	+-	AG	Yale		
907		+-	+	+	2+	+-	AG	Yale		
908	Down	2+	2+	1-2+	2+	+-	AG	Yale		
909		+-	+-	+	2+	+-_0	AG	Yale		
910	Down	+	1-2+	0	+-	+-	AG	Yale	AC002091	Genomic Sequence Human 17, complete sequence
911	Down	2+	2+	2+	+	-	AG	Yale		
T113	Down	2+	2-3+	2+	2+	1-2+	AG	Yale	AI039523	ox371002. si Soares total fetus
912	Down	+-	+-	+-	-	-	AG	Yale		
913	Down	3+	3+	2-3+	2-3+	2+	AG	Yale		
914	Up	-	+-	-	-	+	AG	Yale		

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology	
										'ox96ho8.	
915	Up	+	1-2+	+	1-2+	2+	AG	Yale	AI038932	xi Soares senescent fibroblasts	
T115		2+	2+	2+	2+	2+	AG	Yale			
										Homo sapiens clone NH 048666I22 HTGS	
916	Up	+	+	+	+	2+	AG	Yale	AC005038	phase 1	
917	Down	+-	+-	-	-	-	AG	Yale			
918	Down	+	+	+	+	+-	AG	Yale			
919		+	+	-	+	+	AG	Yale			
920	Down	+	2+	+	+-	+-	AG	Yale			
										Histone H3.3	
T116	Down	3-4+	3-4+	3+	3+	3+	AG	Yale	M11353 H	(human)	
T117	Up	+	+	+	2+	2+	AG	Yale			
										NCI CGAP GC4 Homo Sapiens	
921	Up	1-2+	2+	+	1-2+	2-3+	AG	Yale	AA912471		
922	Down	1-2+	2+	+	1-2+	0-+?	AG	Yale			
923	Down	+-	+-	-	+-	-	AG	Yale			
924	Up	0	0	0	+-	2+	AG	Yale			
925	Down	+-	+	0	0	10	AG	Yale			
926	Down	1-2+	1-2+	+	+-	+	2+	AG	Yale		
										0180a04.s	
927	Up	+	?+	?+	2+	2+	AG	Yale	AA917380	KIDS	
										Homo Soares NFL	
928	Up	0	0	0	0	2+	AG	Yale	AA926999	TGBC si	
929	Down	+	-	+	+	-	AG	Yale			

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
930	Up	0	0	0	+-	2+	AG	Yale	CH29R28 051	AD000864 HomoSapiens DNA from chromosome 19 cosmid R28051
931	Down	2+	2+	1-2+	1-2+	+	AG	Yale		
932	Up	+	+	+	+	2+	AG	Yale		
933	Down	4+	4+	3+	3+	3+	AG	Yale	m81637	Human granclan mRNA
934		-	-	+-	+	+-	AG	Yale		
935	Down	+-	+	+	+	-	AG	Yale		
936		+	+-	+-	+	+	AG	Yale		
937	Up	+-	+-	+-	+-	+	AG	Yale		
938	Up	+-	+-	+-	+	2+	AT	Yale		
939	Up	0	0	+-	+-	2+	AT	Yale	AA916304	NCI CGAP LU5 HOMO SAPIENS
940		+	+	2+	2-3+	+	AT	Yale		
941	Up	+	+	+	+	2-3+	AT	Yale		
942	Up	+	+	+-	0	1-2+	AT	Yale		
943	Down	+-	+-	+-	+	-	AT	Yale		
944	Down	2+	+	+	+-	0	AT	Yale		
945	Up	+	+-	+	+-	+	2+	AT	AA928171	ON86HO3 SOARES NFL TGBC SI
946	Down	+	+	+	-	-	AT	Yale		
947		0	0	+	2+	0	AT	Yale		
948	Down	+	+	+	+-	-	AT	Yale		
949	Up	0	0	0	0	1-2+	AT	Yale	AI038932	HOMO SAPIENS SOARES SENESCENT FIBROBLASTS
950	Down	2-3+	2-3+	2-3+	2-3+	?	AT	Yale		
951	Up	+-	+-	+-	+-	+	AT	Yale		

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology	
952	Up	0	0	0	+-	1-2+	AT	Yale	ACC0045 51	HOMO SAPIENS HTGS PHASE 1	
953	Down	1-2+	+	1-2+	+-	0	AT	Yale			
954	Up	+	+	+	1-2+	2-3+	AT	Yale	AI026998	HOMO SPAIENS SOARES PARATHYROID TUMOR	
955	Down	+	+	+	+	0	AT	Yale			
956	Up	+-	+-	+-	+-	+	AT	Yale			
957	Down	2+	2+	2+	2+	+	AT	Yale			
958	Up	+	+	+	+-	+	2+	AT	Yale		
T123	Up	+-	+-	+	2+	3+	AT	Yale	HS02746 7	HUMAN BCL-2 RELATED (BF1-1) MRNA	
959		+	+-	2+	+	+	AT	Yale			
960	Down	2+	+	+	+	+-	AT	Yale			
961		0	+-	2+	+-	0	+-	0	AT	Yale	
962	Up	0	0	0	0	2+	AT	Yale			
T124	Up	3+	3+	3+	3-4+	3-4+	AT	Yale			
963	Down	2+	2+	2+	2+	+	AT	GLI			
964		+-	1-2+	+	+	+-	AT	GLI			
965	Up	0	0	+-	2+	1-2+	AT	GLI			
966	Down	+	+	+	1-2+	+-	AT	GLI			
967	Down	3+	3+	3+	3+	+-	AT	GLI	M60830	Human gene EVI2B#P	
968	Down	+	+	2+	1-2+	+-	AT	GLI			
969	Up	0	0	0	+-	2+	AT	GLI			
970		0	0	0	2+	0	AT	GLI			
971	Down	+	+	2+	1-2+	+-	AT	GLI			
972	Down	+	+	+	+	-	AT	GLI			
973	Up	-	-	-	-	+	AT	GLI			
974	Up	+	+	2+	3+	2+	CA	Yale			
975		+	+-	1-2+	2+	?	CA	Yale	GBM7769 3	HUMAN DIAMINE ACETYLTRANSFERASE	

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Clones	mRNA Expression Pattern	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
976		1-2+	1-2+	2-3+	3+	?	CA	Yale	Z14136	HOMO SAPIENS GENE SPERMIDINE/SPERMINE N1-ACETYL TRANSFERASE
T132							CA			
T133							CA			
977	Up	+	+	1-2+	2-3+	1-2+	CA	Yale		
T135							CA			
978	Down	2+	2+	2+	2+	-	CA	GLI	G05563	Human STS WI-7246
979	Down	+	+	+	+	-	CA	GLI		
980		-	-	-	+	-	CA	GLI		
981	Down	+	+	+	+	-	CA	GLI	473168	Human cosmid LUCA22
982		-	-	-	+	-	CA	GLI	M55542	Human granulocyte binding M55542 protein Isoform I
983		-	-	-	+	-	CA	GLI		
984		2+	2+	3+	3-4+	2+	CC	Yale	HS167A1 4	Z94721 HUMAN DNA SEQ-PAC167A 14 CHROM6 927
T139	Up	+	+-	+	-	2+	CC	GLI		
985	Down	+	+	+	2+	+-	CC	Yale		
T140	Up	+	+	+	+	2+	CC	GLI		

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Clones	mRNA Expression Patt rn	Control	10'	30'	60'	120'	n1n2	Sequenced by	Closest Genbank Acc. #	Closest Homology
									0V51H11. SI SOARES TESTIS NHT HOMO SAPIENS	
986	Down	2+	2+	1-2+	1-2+	+-	CC	Yale	AI015836	
987		2-3+	2+	2+	3-4+	3+	CC	Yale		

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TABLE 2

Cln	Sequence
846	1 TCTCAGTGAG CTGAGATCAC ACCACTGCAC TCCAACTGGG CGACAGAGCA 51 AG
854	1 CACTTTCCCC AAATTCTTTT GCCATAGTTCACTCTCTACT GATAAGGCCA 51 C
855	1 GGGAAAGTGG TGGGGTGGTG AGGGTCAATG TGCAGAAAAT CGATGTAACT 51 TGTAATACAG TTGAGTCAAC TGTGTGTTCA CAACAACTCT GAGAGTTAAC 101 ACCATTCTA C
856	1 ATCTAAATAT TTTTCATACC GAGTTATTAA GGAGTCAGTA GTCTGTGCTA 51 CAATGCTGCA AAAAGCATCA CGTGGAAAGAA TGGGAACATAT GCGTACTTTA 101 TGAAGTGATG TATAACACAA TGAACCTCTGT TTTACAACTA CAGTGCTGCA 151 TTCAATTATC TTCCAT

-38-

859	1 AAGCTCTGTA TACAAAAGTT ATTTATTTAG ATGTTCGAGG CATGTCTCTC 51 CTCACCTGTA AACTAACTGT TTTATAACAG CTTGTATCAC ATGTGTGAAG 101 TTAATGAATG TAATACTCCA ACAAGCCATT CATCAGATTG GCCAACAGCT 151 AGGATACAGT TAAATAATGG CGACCAGGTT GACAAGTCAT AATTGCGGTT 201 TGGGGGACCG TAGTTGCACC TCACCTAGAC CAACGTACGC ATGGCACTCG 251 ACCCAGGCGA ACAAAATTAA T
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863	1 TTTCTCAAGA AGAGATAAGA ATGAAAAGTC ATAGAACACA TCATGGAGGA 51 CCTGGACACA AATGCAGACA AGCAGCTGAG CTTCGAGGAG TTCATCATGC 101 TGATGGCGAG GCTAACCTGG GCCTCCCACG AGAAGATGCA CGAGGGTGAC 151 GATGCCCTG GCCACCACCA TAAGCCAGGC CTCGGGGAGG GCACCCCTA 201 AGACCACAGT GGACAAGATC ACAGTGGCCA CGGACACGGC CACAGTCATG 251 GTGCCACGG CCACAGCCAC TAATCAGGAG GCCAGGCCAC CCTGCCTCTA 301 CCCAACCAGG GCCCCGGGGC CTGTTATGTC AACTGTCTT GGCTGTGGGG
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866	<p>1 NGATTTCT AGGAGGGAGA CACTGGCCNC TCAAATCGTC CAGCGACCTT</p> <p>51 CCTCATCCAC CCCATCCCTC CCCAGTTCAT TGCACTTGA TTAGCAGCGG</p> <p>101 AACAAAGGAGT CAGACATTT AAGATGGTGG CAGTAGAGGC</p> <p>TATGGACAGG</p> <p>151 GCATGCCACG TGGGCTCATA TGGGGCTGGG AGTAGTTGTC</p> <p>TTTCCTGGCA</p> <p>201 CTAACGTTGA GCCCCTGGAG GCACTGAAGT GCTTAGTGTA</p> <p>CTTGGAGTAT</p> <p>251 TGGGGTCTGA CCCCAAACAC CTTCCAGCTC CTGTAACATA</p> <p>CTGGCCTGGA</p> <p>301 CTGTTTCTC TCGGCTCCCC ATGTGTCCTG GTTCCCGTTT CTCCACCTAG</p> <p>351 ACTGTGAACC TCTCGAGGGC AGGGACCACA CCCTGTACTG</p> <p>TTCTGTGTCT</p> <p>401 TTCACAGCTC CTCCCACAAT GCTGAATATA CAGCAGGTGC</p> <p>TCAATAAATG</p> <p>451 ATTCT</p>
871	1 GCAAGTGTGT TGTGTACAG TGTACACA CCGAG
872	<p>1 GATCTCTCCC TACGCAAAAC GTATTGTAGT GAAAGGGTCT TCTTTACTAC</p> <p>51 CTTAATAAAA CAGCTAGTGT G</p>
874	<p>1 GATCTAAATA CAAAGGATAT ACAGTCTTGA ATCTAAATA ATTTGCTAAC</p> <p>51 TATTTGATT CTTCAGAGAG AACTACTA</p>

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876	1 GATCTAGTCC GGACATGCTG TGTATATTGT AACGTTAAAT GAAAAAAGAA 51 CCCCCCTTG TATTATAGTC ATGCGGTCTT ATGTATGATA AACAGTTG
878	1 GATCTTTGT AGTCACCTCT GTATCTTATG TCTGGTTGAG GGGTGCTTT 51 ACTTGTCTGG CATTGCATT CAATGATCTT TCAGTCATGT CAGTTAGACT 101 AAAAATTATT TCTG
880	1 CCCAAGCCCC TTGGACACTG CAGCTCTTT CAGTTTTGC TTACACACAA 51 TTCATTCTTT GCAGCTAATT AAGCCGAAGA AGCGTGGGAA TCAAGTTGG 101 AACAGAGATT AAAAAGTTC TT
881	1 GCTCTGGAGG ACAATCCAGG AACTACATTA CCTGGACTGT ATGCTGGTCA 51 TTTCTACAGA CAGCATTCAAG TATTGAGTG TACGGTAACT GTCTGGGTG 101 ATTCTATCAA GATCATTATA CTG
882	1 GATCTTCTC CTTGAATATC TTTCGATAAA CAACAAGGTG GTGTGATCTT 51 AATATATTG AAAAAAACCTT CATTCTCGTG AGTCATTTAA ATGTGTACAA 101 TGTACACACT GGTACTTAGA GTTCTGTTT GATTCTTTT TAATAAACTA 151 C
883	1 TGTCACTCAT GCCCTGGGAC TGCTTCTCCA GCCAGGCGGG CGCCATACGT 51 CCCACACTAG TGAAGGTCAA TGTCTCAGAA CAACACCTCT AT

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884	<p>1 GATCTGGCCT GTTCCTGCGT CTGCGGAGCA GGCCCTGTCT CCCAGCTATC</p> <p>51 TATAACCTTA CCTAGAGTGT CGACTTGTGG GTTCCTGTTG CTGAGACTTC</p> <p>101 CTGGATGGAG CCGCCCTCAC CGCCGGACCC GTAGCACTGC</p> <p>GCGGAAGTGT</p> <p>151 GTCCAATAAA GT</p>
885	<p>1 GATCTGATT GCTAGTTCTT CCTTGTAGAG TTATAAATGG AAAGATTACA</p> <p>51 CTATCTGATT AATAGTTCT TCATACTCTG CATATAATT GTGGCTGCAG</p> <p>101 AATATTGTAA TTTGTTGCAC ACTATGTAAC AAAACAACTG</p> <p>AAGATATGTT</p> <p>151 TAATAAATAT TGTACT</p>
894	<p>1 GATCTTATG AGAGCAGTAT TTTCTGTGTT TTCTTTTAA TTTACAGCCT</p> <p>51 TTCTTATTT GATATTTTT TAATGTTGTG GATGAATGCC AGCTTCAGA</p> <p>101 CAGAGCCCAC TTAGCTTGTG CACATGGATC TCAATGCCAA TCCTCCATTG</p> <p>151 TTCCCTCTCCA GATATTTTG GGAGTGACAA ACATTCTCTC ATCCTACTTA</p> <p>201 GCCTACCTAG ATTTCTCATG ACGAGTTAAT GCATGTCCGT GGTTGGGTGC</p> <p>251 ACCTGTAGTT CTGTTTATTG GTCA</p>

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895	<p>1 GATCTAAGTT AGTCCAAAAG CTAATGATT TAAAGTCAAG TTGTAATGCT</p> <p>51 AGGCATAAGC ACTCTATAAT ACATTAATT ATAGGCCGAG CAATTAGGGA</p> <p>101 ATGTTTCTGA AACATTAAC TTGTATTTAT GTCACTAAAA TTCTAACACA</p> <p>151 AACTAAAAAA ATGTGTCTCA TACATATGCT GTACTAGGCT TCATCATGCA</p> <p>201 TTCTAAATT TGTGTATGAT TTGAATATAT GAAAGAATT ATACACGAGT</p> <p>251 GTTATTAAA ATTATTAAA ATAAATGTA</p>
896	<p>1 GATCTTATAG GCCTGTCTCA TCAGGTTGGT GTCAGCCCAG CTAGGATTAG</p> <p>51 GCAGAATTGG GTGGGGGCTG TAGTGCACTT TTGGCACAGC ATGTACCTGT</p> <p>101 CTGACTAATT CTCTGTCTT TCTTCCTGT TGCAATTCA GGGTCTTAGC</p> <p>151 ATCTTCTGAA TGGTGTITAG TAGGTCAATCC TGTTGATTTC CTGCTAGGGA</p> <p>201 GTAGCATACT CTGGCTCTGT ACCACTGGCC AAGGGACTTA AGGATAGATG</p> <p>251 AAGGGCTGCA GTTTGTTAA ATGGAACAAT ATGAAGAGA</p>
T10 3	<p>1 GATCTTCTC CTTGAGTATC TTTCGATAAA CAACAAAGTG GTGTGATCTT</p> <p>51 AATATATTG AAAAAAACTT CATTCTCGTG AGTCATTAA ATGTGTACAA</p> <p>101 TGTACACACT GGTACTTAGA GTTCTGTTT GATTCTTTT TAATAAACTA</p> <p>151 C</p>

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T10 4	1 GATCTCTGCT CATAGAATGC ATGGGGAGCC TTCCAGCTCA CTCTCCCTGA 51 GGACTGGCTT GACAGGGGCT ATGGGTTTGC TTTGG
T10 5	1 GATCTGCGCT TCCAGAGCGC AGCTATCGGT GCTTGCAGG AGGCAAGTGA 51 GGCCTATCTG GTTGGCCTTT TTGAAGACAC CAACCTGTGT GCTATCCATG 101 CCAAACGTGT AACAAATTATG CCAAAAGACA TCCAGCTAGC ACGCCGCATA 151 CGTGGAGAAC GTGCTTAAGA ATCCACTATG ATGGGAAACA
T10 7	1 GATCTAAATG TGAACAGTTT ACTAATGCAC TACTGAAGTT TAAATCTGTG 51 GCACAATCAA TGTAAGCATG GGGTTTGTCTCTAAATTG ATTTGTAATC 101 TGAAATTACT GAACAACTCC TATTCCATT TTTGCTAAAC TCAATTCTG 151 GTTTGGTAT ATATCCATTTC CAGCTTAATG CCTCTAATT TAATGCCAAC 201 AAAATTGGTT GTAATCAAAT TTAAAATAA TAATAATTG GC
T76	1 GCCTTTCGA TAGTTCGGG TCAGGTAAAA ATGGCCTCCT GGCGTAAGCT 51 TTTCAAGGTT TTTGGAGGC TTTTGTAAGG TTGTGATAGG AACTTTGGAC 101 CTTGAACCTA CGTATCATGT GGAGAAGAGC CAATTTAAC AACTAGGAAG 151 ATGAAAAGGG AAATTGTGGC CAAAACTTG GGAAAAGGAG GTTCTTAAAA 201 TCAGTGTTC CCCTTT

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T8	<p>1 GATCTATGCA CAAGAACCCC TTTACCCAT GACCAACATC GCAGACACAT</p> <p>51 GTGCTGGCCA CCTGCTGAGC CCCAAGTGGA ACGAGACAAG CAGCCCTTAG</p> <p>101 CCCTTCCCCT CTGCAGCTTC CAGGCTGGCG TGCAGCATCA GCATCCCTAG</p> <p>151 AAAGCCATGT GCAGCCACCA GTCCATTGGG CAGGCAGATG TTCCTAATAA</p> <p>201 AGCT</p>
T81	<p>1 GATCTTCCCT CCTGGTTACT GTGAAGCCTG TTGGTTTGCT GCTGTCGTTT</p> <p>51 TTGAGGAGGG CCCATGGGGG TAGGAGCAGT TGAACCTGGG AACAAACCTC</p> <p>101 ACTTGAGCTG TGCCTAGACA ATGTGAATTCTGTGTTGCT AACAGAAAGTG</p> <p>151 GCCTGTAAGC TCCTGTGCTC CGGAGGGAAG CATTTCCTGG TAGGCTTTGA</p> <p>201 TTTTCTGTG TGTTAAAGAA ATTCAATCTA CTCATGATGT GTTATGCATA</p> <p>251 AAACATTCT GGAACATGGA TTTGTGTTCA CCTTAAATGT GAAAATAAAT</p> <p>301 CCTA</p>

-46-

T82	1 ATCTTCCTC CTGGTTACTG TGAAGCCTGT TGGTTGCTG CTGTCGTTT 51 TGAGGAGGGC CCATGGGGGT AGGAGCAGTT GAACCTGGGA ACAAACCTCA 101 CTTGAGCTGT GCCTAGACAA TGTGAATTCC TGTGTTGCTA ACAGAAAGTGG 151 CCTGTAAGCT CCTGTGCTCC GGAGGGAAGC ATTCCTGGT AGGCTTGAT 201 TTTTCTGTGT GTTAAAGAAA TTCAATCTAC TCATGATGTG TTATGCATAA 251 AACATTTCTG GAACATGGAT TTGTGTTCAC CTTAAATGTG AAAAATAAATC 301 CTATTTCTA TG
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T85	<p>1 GATCTTGGC AGGCCATTG GACTCTTGG GGTCAATCGTC GCAATTCTTC</p> <p>51 ATACCTCCAG AGTGAAGATG GGTGACTAGA TGATATGTGT GGGTGGGGCC</p> <p>101 GTGCCTCACT TTTATTTATT GCTGGTTTC CTGGGACAGC TGGAGCTGTG</p> <p>151 TCCCTTAACC TTTCAGAGGC TTGGTGTCA GGGCCCTCCC TGCACCTCCCC</p> <p>201 TCTTGCTGCG TGTGATTG GAGGCAGTC AGTCCAGGCC GAGTCCTCAG</p> <p>251 TGCAGGGAGC AGGCTGCTGC TGCTGACTCT GTGCAGCTGC GCACCTGTGT</p> <p>301 CCCCCACCTC CACCCCTCAAC CCATCTCCT AGTGTGTG AAATAAACTT</p> <p>351 GGTAT</p>
T98	<p>1 GATCTTCCAC GTCTCCATCT CAGTACACAA TCATTTAATA TTTCCCTGTC</p> <p>51 TTACCCCTAT TCAAGCAACT AGAGGCCAGA AAATGGGCAA ATTATCACTA</p> <p>101 ACAGGTCTTT GACTCAGGTT CCAGTAGTTC ATTCTAATGC CTAGATTCTT</p> <p>151 TTGTGGTTGT TGCTGGCCA ATGAGTCCCT AGTCACATCC CCTGCCAGAG</p> <p>201 GGAGTTCTTC TTTGTGAGA GACACTGTAA ACGACACAAAG AGAACAAAGAA</p> <p>251 TAAAAA</p>

-48-

933	1 TTATATATTT TTCTTAAATA TGTTTATTG TCTTCTCTAA GCAAAAAGTT 51 CTTAATAAAC ATAGTATTTC TCTCTGCGTC CTATTCATT AGTGAAGACA 101 TAGTCACCT AAAATGGCAT CCTGCTCTGA ATCTAGACTT TTTAGAAATG 151 GCATATGTTT TTGATGATAT GTCAACATTC AAAATAGTCC TAATTAAATT 201 GTTGGTTAAA TGTAATGTCA ACTCTTATA AACTTAAATA TAAACAAGTA 251 ATTAACCACT CTAAGTAATA AAACACATT CACCTGTGTT CTGAGTGTA
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967	1 ATGAATCCTT GCCACCTCCA CCTGCAGAAC TGTTATAAAT ATTACAACCTT 51 GCTTTTAGC TGATCTTCCA TCCTCAAATG ACTCTTTTT CTTTATATGT 101 TAACATATAT AAAATGGCAA CTGATAGTCA ATTTGATT TTATTCAGGA 151 ACTATCTGAA ATCTGCTAG AGCCTATGTG CATAGATGAA ACTTTTTTT 201 AAAAAAAAGTT ATTTAACAGT AATCTATTAA CTAATTATAG TACCTATCTT 251 TAAAGTATAG TACATTTAC ATATGAAAT GGTATGTTTC AATAATTAA 301 GAACTCTGAA ACAATCTACA TATACTTATT ACCCAGTACA GTTTTTTTC 351 CCCTGAAAAG CTGTGTATAA AATTATGGTG AATAAACTTT TATGTTCCA 401 TTTCAAAGAC CAGGGTGGAG AGGAATAAGA GACTAAGTAT ATGCTTCAAG 451 TTTAAATTAA ATACCTCAGG TATTAAAATA AATATTCCAA GTTTGTGGGA 501 AATGGGGAGA TTAAAATG
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978	1 TTATGTGGCC TTAGGTAGCT GGTTGTACAT CTTTCCCTAA ATCGATCCAT 51 GTTACCAACAT AGTAGTTTA GTTTAGGATT CAGTAACAGT GAAGTGTAA 101 CTATGTGCAA CGGTATTGAA GTTCTTATGA CCACAGATCA TCAGTACTGT 151 TGTCTCATGT AATGCTAAAA CTGAAATGGT CCGTGTTCGC ATTGTAAAAA 201 ATGATGTGTG AAATAGAATG AGTGCTATGG TGTTGAAAAC TGCAGTGTCC 251 GTTATGAGTG CCAAAAATCT GTCTGAAGG CAGCTACACT TTGAAGTGGT 301 CTTTGAATAAC TTTAATAAA TTTATTTGA TA
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981	1 TAGGTGAACC CTTATTCTGC AGGGTTCTCC CTCCCACCTT AAAGAAGTTC 51 CCCTTATGTG GGTTGCCTGG TGAATGGCCT TCCTTCCCGC CAGAGGGCTT 101 GTGAACAGAC CGGAGAGGAC AGTGGATTGT TTATACTCCA GTGTACATAG 151 TGTAATGTAG CGTGTITACA TGTGTAGCCT ATGTTGTGGT CCATCAGCCC 201 CTCACATTCC TAGGGGTTG AGATGCTGTA CGTGGTATGT GACACCAAAG 251 CCACCTCTGT CATTGTTGT GATGTCCTTT CTTGGCAAAA GCCTTGTGTA 301 TATTTGTATA TTACACATTT GTACAGAATT TTGGAAGATT TTCAGTCTAG 351 TTGCCAAATC TGGCTCCTTT ACAAAAG
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982	<p>1 AGAACCTCTT ATGTTCTCAG AGGAAGGTGG AAGAAACCAT GGGCAGGAGT</p> <p>51 AGGAATTGAG TGATAAACAA TTGGGCTAAT GAAGAAAATC TCTCTTATTG</p> <p>101 TTCAGTTCAT CCAGATTATA ACTTCAATGG GACACTTAG ACCATTAGAC</p> <p>151 AATTGACACT GGATTAACAA AATTACACATA ATGCCAATA CACAATGTAT</p> <p>201 TTATAGCAAC GTATAATTG CAAAGATGGA CTTTAAAAGA TGCTGTGTAA</p> <p>251 CTAAACTGAA ATAATTCAAT TACTTATTAT TTAGAATGTT AAAGCTTATG</p> <p>301 ATAGCTTTT CTAATTCTTA ACACTCATAC TTGAAATCTT TCTGAGTTTC</p> <p>351 CCCAGAAGAG AATATGGGAT TTTTTTGAC ATTTTGACT CATTAAATAA</p> <p>401 TGCTCTTGTG TTTACCTAGT ATATGTAGAC TTTGTCTTAT GTGTCAAAAG</p> <p>451 TCCTAGGAAA GTGGTTGATG TTTCTTATAG CAATTAAAAA TTATT</p>
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905	<p>1 ATCTCAGTGA GCTGAGATCA CACCACTGCA CTCCAAGTGG GCGACAGAGC</p> <p>51 AAGA</p>
910	<p>1 GATCTGTAAT TCAGGTGTT TCTGTACAGC CATACTAGA TAATGAAGCC</p> <p>51 AAAAGGCTTT TAATTACACC ATGGCCTAAA ATAAATTCTCAT CA</p>

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915	1 TATTTTCAG CTGAGTTATT AGGGAGTCAT TATTCTGTGG TACAATGCTG 51 CAAAAAGCAT CATGTGGAAG AATGGGAACAT ATGCTTACAT TATGAAGTGA 101 TGTATAACAC AATGCAAATC TG
916	1 GATCTTTTT CATTAACAAA TGTTCAATT TCAGGCCGGG TGCAGTGGGG 51 CTCATGCCTG TAATCCCAAC ACTTTGGGAG GCCGATGCAG GC GGATCACT 101 AGGTCAGCAG ATCGAGACCA TCCTGGCTAA CACAGTGAAA CCT
921	1 GATCTTATT TTAGCCATG CACTGTTGTG AGGAAAATTAA CCTGTCTTGA 51 CTGCCATGTG TTCATCATCT TAAGTATTGT AAGCTGCTAT GTATGGATTT 101 AAACCGTAAT CATATCTTT TCCTATCTAT CTGAGGCAGT GGTGGAATAA 151 AGAACCTGTA TATTTTACTT TGTTGCAGAT AGTCTTGCAG CATCTTGGCA 201 AGTTGCAGAG A

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927	<p>1 GATCTTCGTG AAGACCTGAC TGGTAAGACC ATCACCCCTCG AGGTGGAGCC</p> <p>51 CAGTGACACC ATCGAGAATG TCAAGGCAA GATCCAAGAT</p> <p>AAGGAAGGCA</p> <p>101 TCCCTCCTGA TCAGCAGAGG TTGATCTTG CTGGGAAACA</p> <p>GCTGGAAGAT</p> <p>151 GGACGCACCC TGTCTGACTA CAACATCCAG AAAGAGTCCA</p> <p>CTCTGCACCTT</p> <p>201 GGTCCCTGCGC TTGAGGGGG GTGTCTAAGT TTCCCCTTT AAGGTTCAA</p> <p>251 CAAATTCAT TGCACTTCC TTTCAATAAA GTTG</p>
928	<p>1 GATCTTCCT CCTGGTTACT GTGAAGCCTG TTGGTTGCT GCTGTCGTT</p> <p>51 TTGAGGAGGG CCCATGGGG TAGGAGCAGT TGAACCTGGG</p> <p>AACAAACCTC</p> <p>101 ACTTGAGCTG TGCCTAGACA ATGTGAATTCTGTGTTGCT</p> <p>AACAGAAGTG</p> <p>151 GCCTGTAAGC CCCTGTGCTC CGGAGGGAAAG CATTCTGG</p> <p>TAGGCTTGA</p> <p>201 TTTTCTGTG TGTAAAGAA ATTCAATCTA CTCATGATGT GTTATGCATA</p> <p>251 AACATTTCT GGAACATGGA TTTGTGTTCA CCTTAAATGT</p> <p>GAAAATAAAT</p>

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930	<p>1 GATCTTCGG GTTCTCTCTC CTAACTCAGC TCTTCGTCC CAGAAACCCA</p> <p>51 GATGTAATCC CCCTACGTGG TGCTTGGGGC ATCCCGATAC CATCTCAGTA</p> <p>101 AATCTCCTAC ATTGGCCTCC TCACCCCTCCC CGGGACCCAC ACCCTTCAGG</p> <p>151 TCCTCACCCCT GAGACAGGGAG GGACCCCTTG AGATCAGGGA</p> <p>CCCTTAGGTC</p> <p>201 TCACTGCTCT CTGATTATA GCTCAACTGG GCCCCCAGTT CCATACCCCA</p> <p>251 GCATTCCCGG TCACTCCCTC CCTAATCTGA GCATCACTCA AGCTCTTAT</p> <p>301 TAAACTC</p>
939	<p>1 ATCTCTCTCC CTACGCAAAA CCCTATTGTA GTAAAAAAAGT CTTCTTTACT</p> <p>51 ATCTTAATAA AACAGATATT GTG</p>
945	<p>1 ATCTATTCTT GTAGATTTT TTTGTGTGGG TCTATGTTC ATTCACTCTGC</p> <p>51 TTTCAGGCTG GATTTATAAC AAGCAGAACT TTTAAAACG</p>
949	<p>1 GATCTAAATA TTTTCAGCT GAGTTATTAC GGAGTCATTA TTCTGTGGTA</p> <p>51 CAATGCTGCA AAAAGCATCA TGTGGAAGAA TGGGAACATAT</p> <p>GCTTACTTTA</p> <p>101 TGAAGTGATG TATAACACAA TGAAA</p>
952	<p>1 CTACCCCGTG ACTCAGTTAC CTCCCCTGG GTCCCTCCCA CATCATGTGG</p> <p>51 GAATTGTAGG AGCTACAATT CAAGATGAGA TTTGGATGGG</p> <p>GTCACAGCCA</p> <p>101 AACCATATCA CTGAGGTATC AAGGAGATTCTT</p>

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954	1 GATCTGATT GCTAGTTCTT CCTTGTAGAG TTATAAATGG AAAGATTACA 51 CTATCTGATT AATAGTTCT TCATACTCTG CATATAATT GTGGCTGCAG 101 AATATTGTAA TTTGTTGCAC ACTATGTAAC AAAACAAC TG AAGATATGTT 151 TAATAAATAT TGTACTTATT G
975	1 NGATCTTCT CCTTGAATAT CTTTCGATAA ACAACAAGGT GGTGTGATCT 51 TAATATATT GAAAAAAACT TCATTCTCGT GAGTCATTAA AATGTGTACA 101 ATGTACACAC TGGTACTTAG AGTTCTGTT TGATTCTTT TTAATAAA
976	1 GATCTGCTAG AAGATGGTTT TGGAGAGCAC CCCTTTACC ACTGCCTGGT 51 TGCAGAAGTG CCGAAAGAGC ACTGGACTCC GGAAGGTAAC CCCTCGCCCT 101 TTCCAGAAGC CAGAGAGACC AAGTGTATG TAAGAAGTAG TGTCGGCTGT 151 GTAGAACAC TGACTACACA GGCGAAGTT ACTGAGAACT TGGACAGAAA 201 AAATAGCCAG CAAGTGT
984	1 CATTCACACA TTTAACCTCC TTCCATACCA AATCTT
986	1 GATCTGGACA GCAGAATGTT ATAACGCAAG TTCAATGTGTT GCTCCCAACT 51 CCATTCTCTT TTCTCTCGTG CAACCAGTTT GCCCATTCTC TTCTTATTAC 101 TTGCTC

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T11 3	1 TCAGAGATTT GCAAAGACTC ACGTTTTGT TGTTTCTCA TCATTCATT 51 GTGATACTAA GAAACTAAGA AGCTTAATGA AAAGAAATAA AATGCCTATG
T11 6	1 GATCTGCGCT TCCAGAGCGC AGCTATCGGT GCTTGCAGG AGGCAAGTGA 51 GGCCTATCTG GTTGGCCTTT TTGAAGACAC CAACCTGTGT GCTATCCATG 101 CCAAACGTGT AACAAATTATG CCAAAGACA TCCAGCTAGC ACGCCGCATA 151 CGTGGAGAAC GTGCTTAAGA ATCCACTATG ATGGAAACA
T12 3	1 GATCTGTGAA ATGCTATCTC TCCTGAAGCA ATACTGTTGA CCAGAAAGGA 51 CACTCCATAT TGTGAAACCG GCCTAATTTC TCTGACTGAT ATGGAAACGA 101 TTGCCAACAC ATACTTCTAC TTTAAATAA ACAACTTGA TGATGTAAC 151 TGACCTTCCA GAGTTATGGA AATTTGTCC CCATGTAATG AATAAATTGT 201 ATGTAT

Example 4

Production of expression profiles generated from cDNAs made with RNA isolated from neutrophils isolated from a subject with a sterile inflammatory disease.

Neutrophils are isolated from normal donor peripheral blood following the LPS-free
5 method or from subjects exhibiting the symptoms of a sterile inflammatory disease.
RNA is extracted and the gene expression profiles prepared as described in Example 1.

To determine the identity of genes (cDNAs) which are differentially expressed in the neutrophils isolated from a subject exhibiting the symptoms of a sterile inflammatory disease, the cDNA profiles prepared from neutrophils from said subject are compared to profiles prepared from neutrophils isolated from the normal donor.

5 Bands which exhibit altered intensities when compared between the gene expression profiles prepared from neutrophils from said subject and profiles prepared from neutrophils isolated from the normal donor are then extracted from the display gel as previously described in Example 1. The isolated fragments are then reamplified using 5' and 3' primers, subcloned into pCR-Script (Stratagene) and sequenced using an ABI
10 automated sequencer.

Once sequences are obtained which correspond to the bands of interest, the sequences can be compared to known nucleic acid sequences in the available data bases.

Example 5.

*Method to identify a therapeutic or prophylactic agent that modulates the response of a
15 granulocyte population to a pathogen*

The methods set forth in Example 1 offer a powerful approach for identifying therapeutic or prophylactic agents that modulate the expression of neutrophils or other granulocytic cells to a pathogen. For instance, profiles of normal granulocytes and neutrophils or other granulocytes exposed to pathogens such as *E. coli*, *Y. pestis* or other
20 pathogenic bacteria are prepared as set forth in Example 1. A profile is also prepared from a granulocyte population that has been exposed to the pathogen in the presence of the agent to be tested. By examining for differences in the intensity of individual bands between the three profiles, agents which up or down regulate genes of interest in the pathogen exposed granulocytes can be identified.

25 As a specific example, screening for agents which up or down regulate the expression of human pre-B cell enhancing factor (PBEF) can be identified by

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examining the differences in band intensity between profiles produced from normal granulocytes, granulocytes exposed to the pathogen and granulocytes exposed to the pathogen in the presence of the agent to be tested. As shown in Figure 4, PBEF is expressed at high levels when exposed to avirulent bacteria, including *E. coli* K12 and 5 avirulent *Y. pestis* but is not expressed at high levels in granulocytes exposed to pathogenic *Y. pestis*. Agents that up regulate PBEF expression as demonstrated by increased band density in the profile produced from granulocytic cells exposed to virulent *Y. pestis* in the presence of the agent may be useful in modulating the response of neutrophils to bacterial infection.

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Example 6

Method to identify a therapeutic or prophylactic agent that modulates the expression of genes in a granulocyte cell population found in a subject having a sterile inflammatory disease.

5 The methods set forth in Example 4 offer a powerful approach for identifying therapeutic or prophylactic agents that modulate the expression of neutrophils or other granulocytic cells in subjects exhibiting the symptoms of a sterile (non-infectious) inflammatory disease. For instance, gene expression profiles of normal granulocytes and granulocytes from a subject exhibiting the symptoms of a sterile inflammatory

10 disease are prepared as set forth in Examples 1 and 4. A profile is also prepared from a granulocyte population from a subject exhibiting the symptoms of a sterile inflammatory disease that have been exposed to the agent to be tested. By examining these profiles for differences in the intensity of band between the three profiles, agents which up or down regulate genes of interest in a granulocytic population from a subject

15 exhibiting the symptoms of a sterile inflammatory disease can be identified. Agents that up-regulate a gene or genes that are expressed at abnormally low levels in a granulocytic cell population from a subject exhibiting the symptoms of a sterile inflammatory disease compared to a normal granulocytic cell population as well as agents that down regulate a gene or genes that are expressed at abnormally high levels

20 in a granulocytic cell population from a subject exhibiting the symptoms of a sterile inflammatory disease are contemplated.

Example 7

Production of solid support compositions comprising groupings of nucleic acids that correspond to the genes whose expression levels are modulated in a granulocytic population that has been exposed to a pathogen or nucleic acids that correspond to the genes whose expression levels are modulated in a granulocytic cell population from a subject having a sterile inflammatory disease.

As set forth in Examples 1-4, expression profiles from granulocytic cells exposed to a pathogen or granulocytic cells from a subject having a sterile inflammatory disease yield the identity of genes whose expression levels are modulated compared to normal, quiescent granulocytic cells.

- 5 Solid supports can be prepared that comprise immobilized representative groupings of nucleic acids corresponding to the genes or fragments of said genes from granulocytic cells whose expression levels are modulated in response to exposure to a pathogen or in a subject having a sterile inflammatory disease. For instance, representative nucleic acids can be immobilized to any solid support to which nucleic acids can be immobilized, such as positively charged nitrocellulose or nylon membranes (see Sambrook *et al.* (1989) *Molecular Cloning: a laboratory manual* 2nd., Cold Spring Harbor Laboratory) as well as porous glass wafers such as those disclosed by Beattie (WO 95/11755). Nucleic acids are immobilized to the solid support by well established techniques, including charge interactions as well as attachment of derivatized nucleic acids to silicon dioxide surfaces such as glass which bears a terminal epoxide moiety. A solid support comprising a representative grouping of nucleic acids can then be used in standard hybridization assays to detect the presence or quantity of one or more specific nucleic acid species in a sample (such as a total cellular mRNA sample or cDNA prepared from said mRNA) which hybridize to the nucleic acids attached to the solid support. Any hybridization methods, reactions, conditions and/or detection means can be used, such as those disclosed by Sambrook *et al.* (1989) *Molecular Cloning: a laboratory manual* 2nd., Cold Spring Harbor Laboratory, Ausbel *et al.* (1987) *Current Protocols in Molecular Biology*, Greene Publishing and Wiley-Interscience or Beattie (WO 95/11755).
- 10
- 15
- 20
- 25 One of ordinary skill in the art may determine the optimal number of genes that must be represented by nucleic acid fragments immobilized on the solid support to effectively differentiate between samples, *e.g.* neutrophils exposed to various pathogens or neutrophils isolated from a patient to be tested for a sterile inflammatory disease.

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Preferably, at least about 5, 10, 20, 50, 100, 150, 200, 300, 500, 1000 or more preferably, substantially all of the detectable mRNA species in a cell sample or population will be present in the gene expression profile or array affixed to a solid support. More preferably, such profiles or arrays will contain a sufficient representative 5 number of mRNA species whose expression levels are modulated under the relevant infection, disease, screening, treatment or other experimental conditions. In most instances, a sufficient representative number of such mRNA species will be about 1, 2, 5, 10, 15, 20, 25, 30, 40, 50, 50-75 or 100 in number and will be represented by the nucleic acid molecules or fragments of nucleic acid molecules immobilized on the solid 10 support. For example, nucleic acids encoding all or a fragment of one or more of the known genes or previously reported ESTs that are identified in Fig.4 and Tables 1 and 2 may be so immobilized. The skilled artisan will be able to optimize the number and particular nucleic acids for a given purpose, i.e., screening for modulating agents, identifying activated granulocytes, etc.

15 Example 9.

Method of diagnosing exposure of a subject to a pathogen.

Expression profiles of RNA expression levels from neutrophils exposed to various bacteria, such as those disclosed in Examples 1 and 3, offer a powerful means to diagnose exposure of a subject to a pathogen. As set forth in Examples 1 and 3, the 20 display patterns generated from cDNAs made with RNA isolated from neutrophils exposed to pathogenic and nonpathogenic *E. coli* and *Y. pestis* exhibit unique patterns of cDNA species corresponding to neutrophil mRNA species (genes) whose expression levels are modulated in response to contact of the neutrophils with the bacteria. The contacting of neutrophils with different species of pathogens may result in the 25 production of expression profiles that are unique to each pathogen species or strain. These unique expression profiles are useful in diagnosing whether a subject has been exposed to or is infected with a given pathogen.

Briefly, expression profiles are produced as set forth in Example 1 using neutrophil samples exposed to various pathogens, such as pathogenic strains of *E. coli*, *Y. pestis*, *Staphylococci*, *Streptococci* or any other bacterial species. Neutrophils are then isolated from the subject to be tested for exposure to a pathogen and an expression profile

5 prepared from the subject's neutrophils by the methods set forth in Example 1. The expression profile prepared from the subject neutrophils can then be compared to the expression profiles prepared from neutrophils exposed to the various pathogen species or strains to determine which expression profile most closely matches the expression profile prepared from the subject, thereby, diagnosing exposure of the subject to a

10 pathogen.

Example 10

Method of diagnosing a sterile inflammatory disease in a subject

Expression profiles of RNA expression levels from neutrophils isolated from a subject having a sterile inflammatory disease, such as those disclosed in Example 4,

15 offer a powerful means to diagnose inflammatory diseases such as psoriasis, rheumatoid arthritis, glomerulonephritis, asthma, cardiac and renal reperfusion injury, thrombosis, adult respiratory distress syndrome, inflammatory bowel diseases such as Crohn's disease and ulcerative colitis and periodontal disease. As set forth in Example 4, the gene expression profiles generated from cDNAs made with RNA isolated from

20 neutrophils from subjects having various sterile inflammatory diseases may exhibit unique patterns of cDNA species corresponding to neutrophil mRNA species (genes) whose expression levels are modulated during the inflammatory process. These unique expression profiles are useful in diagnosing whether a subject has a sterile inflammatory disease.

25 Briefly, expression profiles are produced as set forth in Examples 1 and 4 using neutrophil samples isolated from patients with various sterile inflammatory diseases. Neutrophils are then isolated from the subject to be tested and an expression profile

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prepared from the subject's neutrophils by the methods set forth in Example 1. The expression profile prepared from the subject neutrophils can then be compared to the expression profiles prepared from neutrophils isolated from patients with various sterile inflammatory diseases to determine which expression profile most closely matches the 5 expression profile prepared from the subject, thereby, diagnosing whether the subject has a sterile inflammatory disease.

It should be understood that the foregoing discussion and examples merely present a detailed description of certain preferred embodiments. It therefore should be apparent to those of ordinary skill in the art that various modifications and equivalents can be 10 made without departing from the spirit and scope of the invention. All articles, patents and texts that are identified above are incorporated by reference in their entirety.

What is Claimed Is:

1. A method to identify a therapeutic or prophylactic agent that modulates the response of a granulocyte population to a pathogen, comprising the steps of:
 - preparing a first gene expression profile of a quiescent granulocyte population;
 - preparing a second gene expression profile of a granulocyte population exposed to the pathogen;
 - treating the exposed granulocyte population with the agent;
 - preparing a third gene expression profile of the treated granulocyte population;

comparing the first, second and third gene expression profiles; and

identifying agents that modulate the response of a granulocytic population to the pathogen.
- 15 2. The method of claim 1, wherein the granulocyte population is selected from the group consisting of a population of neutrophils, basophils and eosinophils.
3. The method of claim 1, wherein the pathogen is selected from the group consisting of bacteria, viruses, fungi and parasites.
4. The method of claim 3 wherein the pathogen is selected from the group consisting of Gram positive and Gram negative bacteria.
- 20 5. The method of claim 3, wherein the pathogen is selected from the group consisting of Staphylococci, Streptococci, Clostridia, Neisseria, Enterobacteriaceae, Helicobacter, Vibrio, Campylobacter, Pseudomonas, Haemophilus, Bordetella,

Mycoplasma, Ureaplasma, Legionella, Spirochetes, Mycobacteria, Actinomyces, Nocardia, Chlamydia, Rickettsia, Coxiella, Ehrlichia, Rochalimaea, Brucella, Yersinia, Francisella, and Pasteurella.

6. A method to identify a therapeutic agent that modulates the expression of at least one gene in a granulocyte population found in a subject having a sterile inflammatory disease; comprising the steps of:

preparing a first gene expression profile of a granulocyte population in a subject having the sterile inflammatory disease;

treating the granulocyte population with the agent;

10 preparing a second gene expression profile of the treated granulocyte population;

comparing the first and second gene expression profiles with the gene expression profile of a normal granulocyte preparation; and

15 identifying an agent that modulates the expression of at least one gene whose transcription levels are altered in the granulocyte population of the subject as compared with normal granulocyte population.

7. The method of claim 6, wherein the granulocyte population is selected from the group consisting of a population of neutrophils, basophils and eosinophils.

8. The method of claim 6, wherein the sterile inflammatory disease is selected from the group consisting of psoriasis, rheumatoid arthritis, glomerulonephritis, asthma, cardiac and renal reperfusion injury, thrombosis, adult respiratory distress syndrome, inflammatory bowel diseases such as Crohn's disease and ulcerative colitis and periodontal disease.

9. A composition comprising a grouping of nucleic acids that correspond to the genes or fragments of genes whose expression levels are modulated in a granulocyte population that has been exposed to a pathogen affixed to a solid support.

10. A composition comprising a grouping of nucleic acids that correspond to the 5 genes or fragments of genes whose expression levels are modulated in a granulocyte population found in a subject having a sterile inflammatory disease affixed to a solid support.

11. A method of diagnosing exposure of a subject to a pathogen, comprising the steps of:

10 preparing a first gene expression profile of a granulocyte population from the subject;

comparing the first gene expression profile to a second gene expression profile of a granulocyte population exposed to the pathogen and to a third gene expression profile of a normal granulocyte preparation; and

15 determining if the subject was exposed to a pathogen.

12. A method of diagnosing a sterile inflammatory disease in a subject, comprising the steps of:

preparing a first gene expression profile of a granulocyte population from the subject;

20 comparing the first gene expression profile to at least one second gene expression profile from a granulocyte population from a subject having a sterile inflammatory disease and to a third gene expression profile of a normal granulocyte population; and

determining if the subject has a sterile inflammatory disease.

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13. The method of claim 12, wherein the sterile inflammatory disease is glomerulo-nephritis.

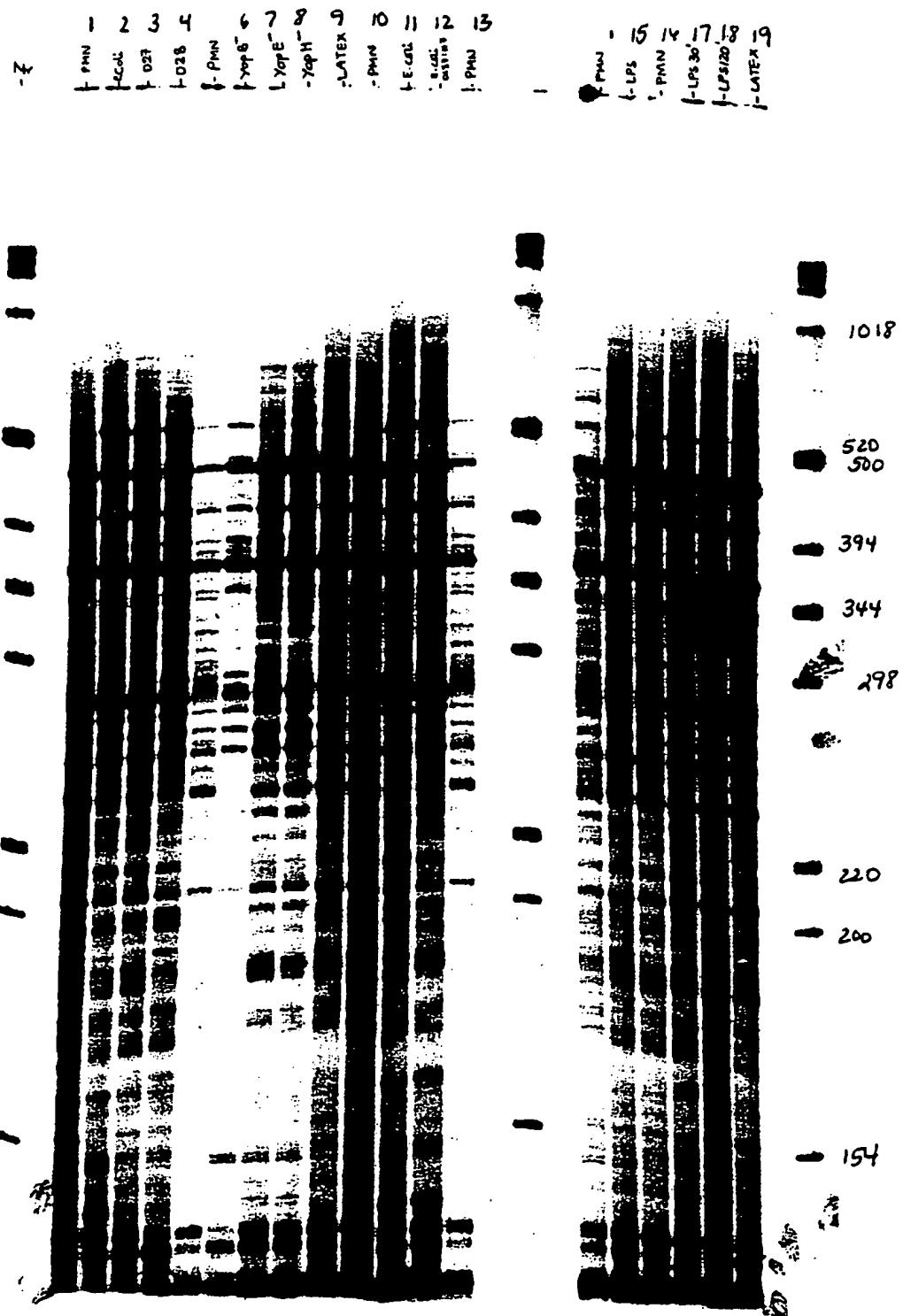


FIG. 1

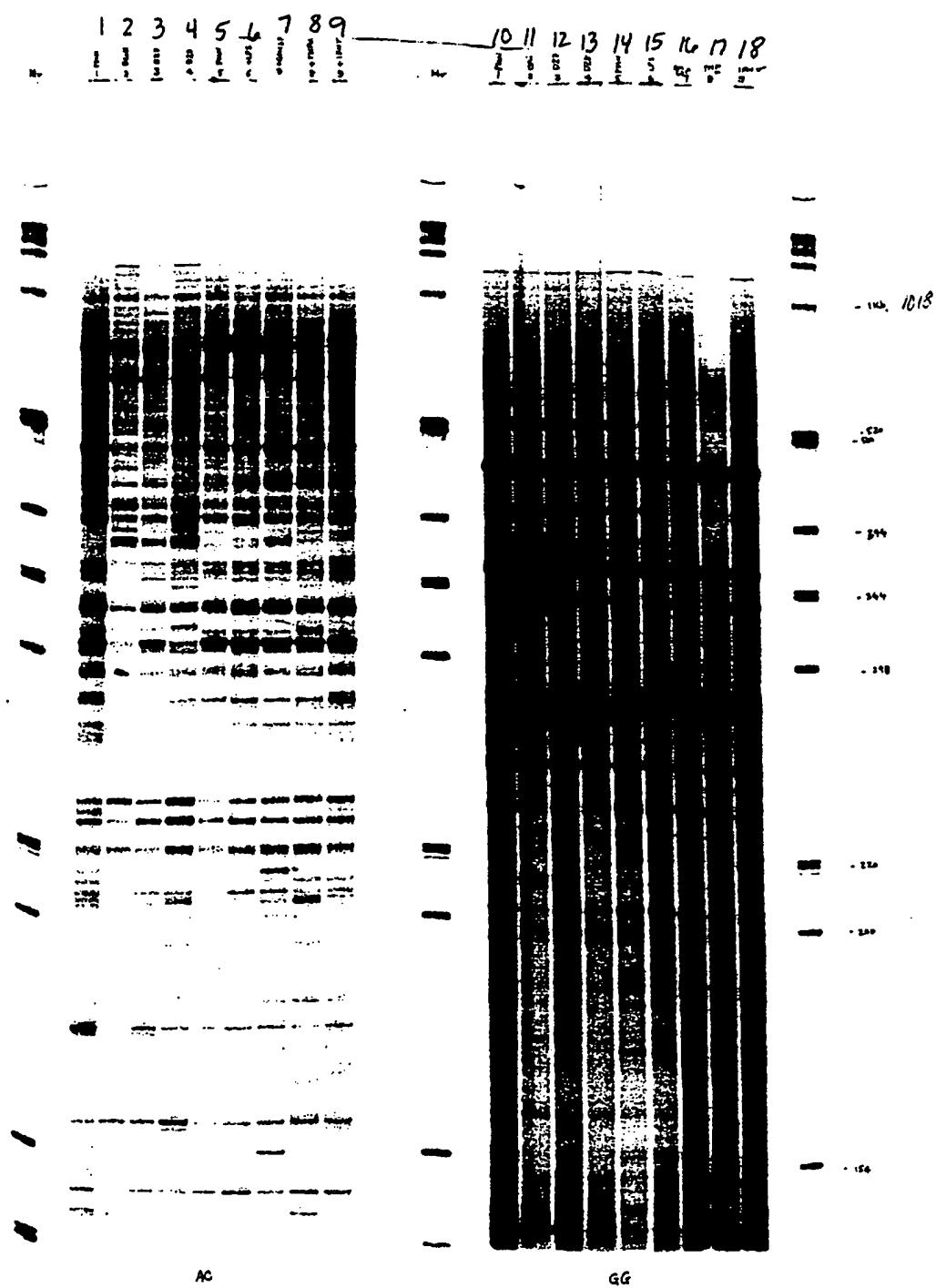
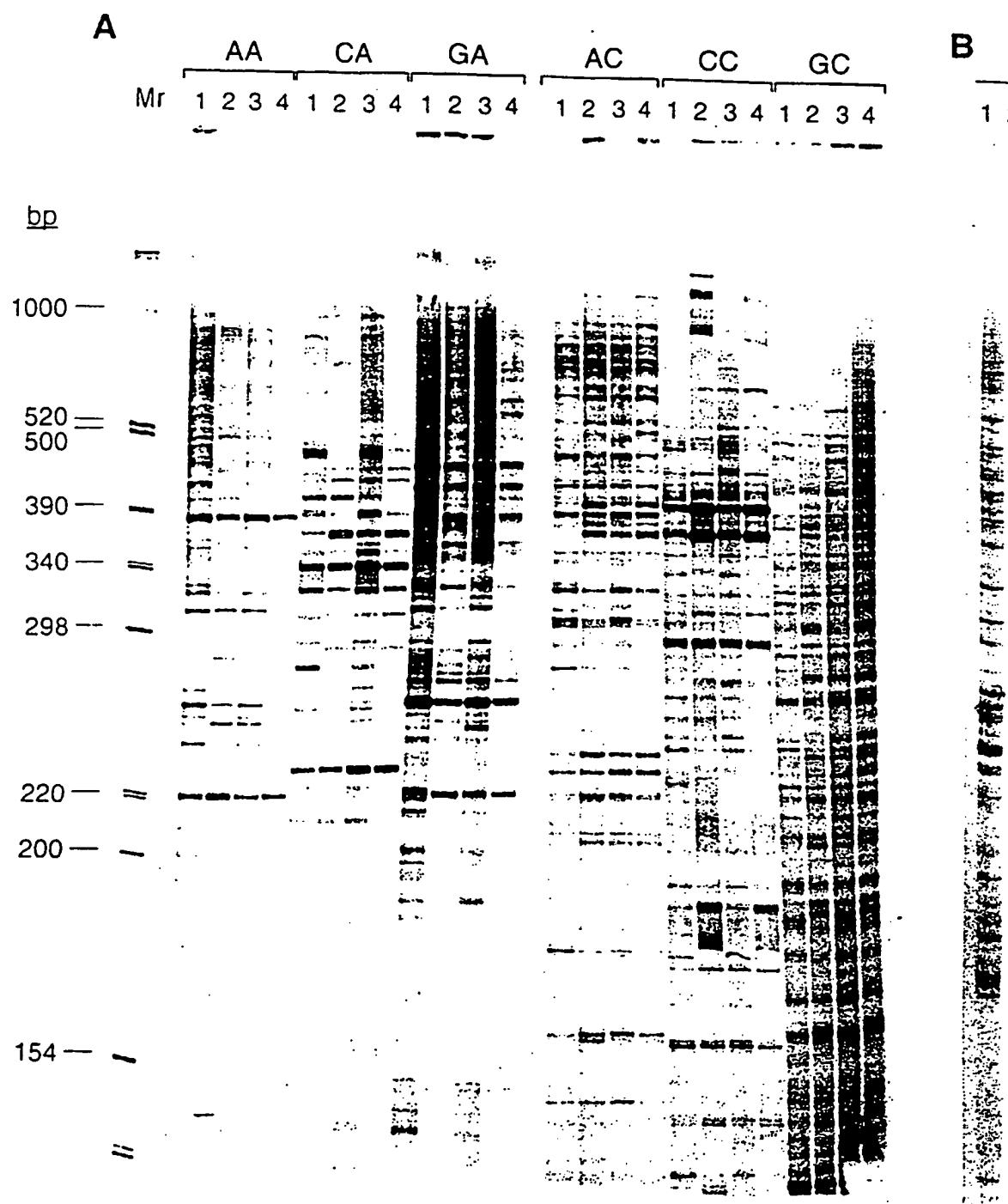


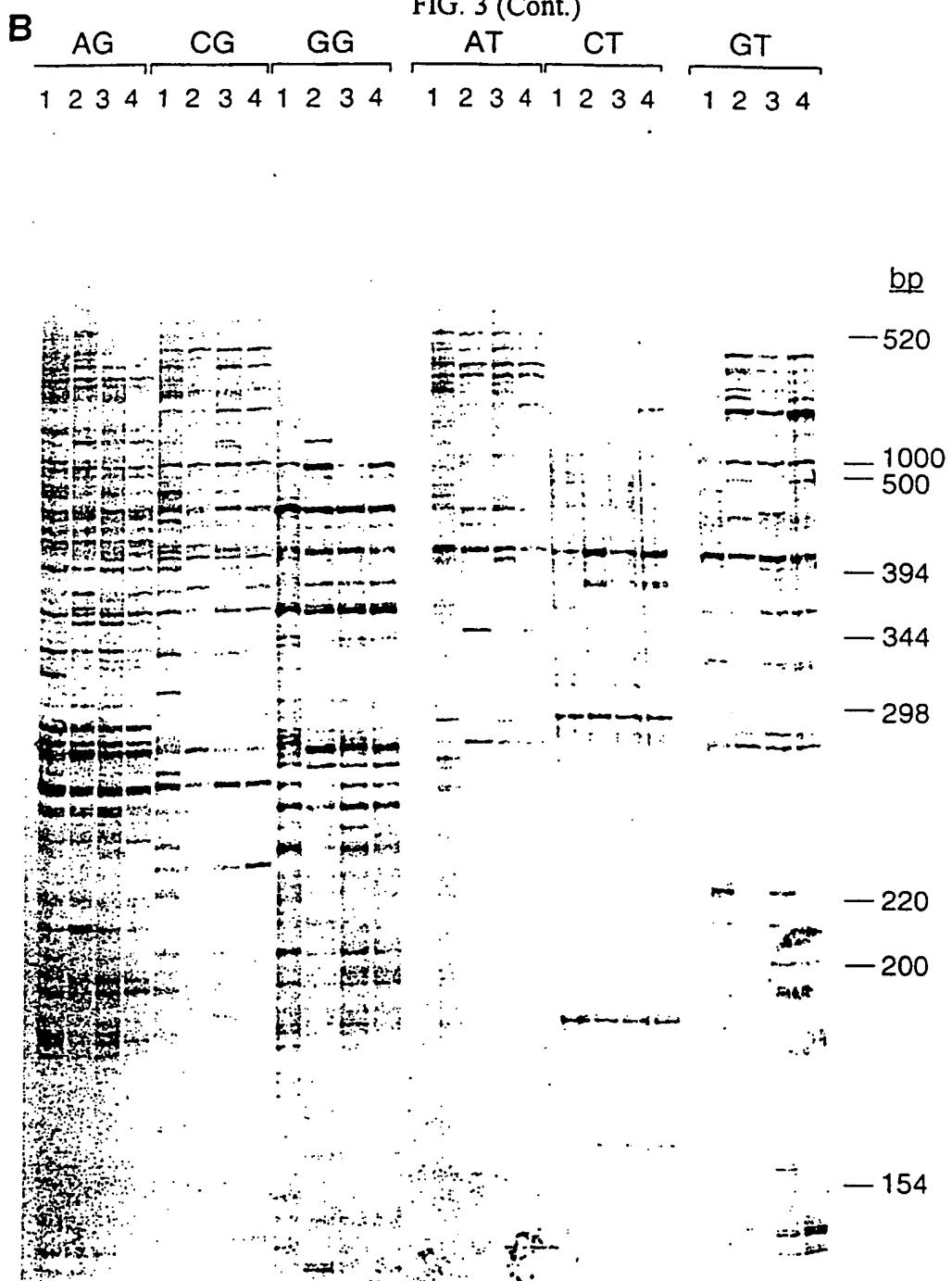
FIG. 2

FIG. 3



- 1) Neutrophils alone
- 2) Neutrophils + *E. coli*
- 3) Neutrophils + V

FIG. 3 (Cont.)



3) Neutrophils + Virulent *y. pestis* 4) Neutrophils + Avirulent *y. pestis*

No.	Clones	N1N2	Expression Patterns				Summary of Results (I)		Known Genes	
			Control		E. coli	Virtulent	Avirulent			
			+	0				++		
1	NP102-3	AA	0	+				+	NADH-ubiquinone oxidoreductase ASH1 subunit	
2	IN12-B12	AC	+	+++	++			+++	human ubiquitin/polyubiquitin	
3	NP104-5	AA	+	+++	++			++	MAP kinase kinase 3b	
4	NP131-3	CA	++	+	++++			++++	cdc2/CDC28-like protein kinase (clk1)	
5	B20-4	AC	+++	++	±		+		human cyclin-dependent kinase inhibitor	
6	NP119-1	AG	0	+	0			++	bcl-2 related (bfl-1) mRNA	
7	NP126-3	AT	0	+++	+			+++	human B-cell lymphoma 3-encoded protein bcl-3 mRNA	
8	NP124-3	AT	++	+++	++			+++	helix-loop-helix basic phosphoprotein (GOS8)	
9	B14-3	AC	++	+++	0			+	human nucleolar phosphoprotein B23 (nucleophosmin)	
10	IN23-E11	AC	±	+++	+			+++	LD78 β (human homolog of mouse MTF1α)	
11	NP125-2	AT	0	++	±			++	LD78 receptor (HM74)	
12	NP149-1	CG	+++	+	++			++	vacuolar H ⁺ pumping ATPase (16KD protolipid subunit)	
13	B23-2	AC	++	+++	+			++	vacuolar H ⁺ pumping ATPase (56KD subunit)	
14	NP139-1	CC	±	++	+			+++	plasma membrane Ca2+ pumping ATPase (56KD subunit)	
15	NP105-1	AA	+++	±	+			++	human H3.3 gene exon 4	
16	NP128-3	CA	0	+	++			+++	ribosomal protein S19	

FIG. 4

No.	Clones	N1N2	Differential Display			Summary of Results (I)	Known Genes
			control	E. coli	Virulent		
17	IN20-E8	AC	+	±	++	±	ribosomal protein S20
18	NP127-2	AT	+	+	±	+	poly(A) binding protein II
19	NP103-3	AA	++	+++	+	++++	Spermidine/Spermine N1-acetyltransferase
20	NP132-2	CA	+	±0	+	++	human GDP-dissociation inhibitor (LY-GDI)
21	B4-1	AC	++	+++	+	+	bovine GTP binding regulatory protein γ -6 subunit
22	NP107-2	AA	++++	++	+++	+++	human B4-2 protein
23	NP156-1	CG	++	+	++	++	ras-related protein p23/Rab-7
24	B5-4	AC	±	+++	+	++	mouse ras-related YTP1 protein/Rab-1A
25	B14-4	AC	+	+++	+	++++	human pre-B cell enhancing factor (PBEF)
26	B22-2	AC	++	+++	+	++	human complement decay accelerating factor
27	Bam1	AC	+	++	++++	++	TNF α inducible protein B94

FIG. 4 (Cont.)

No.	Clones	NIN2	Expression Patterns			Gene Bank Search and Analysis	
			Control	E. coli	Virulent	Avidulent	EST Sequences
1	NP101-3	AA	++	++	0	++	EST (GB/L81699/HSIL81699)
2	NP108-3	AA	++	+	+	++	EST (GB/R09487/R09487)
3	NP113-2	AG	++	+	++	+	EST (GB/L79267/HSU79267)
4	NP114-2	AG	+++	+	++	+++	EST (GB/N26756/N26756)
5	NP115-3	AG	++	+	+++	+++	EST (GB/L49761/HUM78188)
6	NP116-3	AG	+	+	++	+	EST (EMB/F10736/HSC31C022)
7	NP117-2	AG	±	+++	++	+++	EST (GB/AA004905/AA004905)
8	NP120-3	AG	±	+	++	+	EST (GB/R16810/R16810)
9	NP121-2	AG	±	++	+	++	EST (GB/AA159075/AA159075)
10	NP122-1	AT	0	+	±	++	EST (GB/AA016979/AA016979)
11	NP133-1	CA	+++	++	+++	+++	EST (GB/AA190718/AA190718)
12	NP134-2	CA	0	±	++	+	EST (GBT29287/T29287)
13	NP138-1	CC	+	++	+	+++	EST (GBT58520/T58520)
14	NP150-1	CG	+	+++	+++	+++	EST (GB/AC001223/HSAC001223)
15	B7-1	AC	++	+	+	0	EST (DIB/D600833/HUM083/H05A)
16	B8-1	AC	+++	+	++	0	EST (GB/R37008/R37008)

FIG. 4 (Cont.)

No.	Clones	NIN2	Differential Display			Summary of Results (I)	EST Sequences	Gene Bank Search and Analysis
			Control	E. coli	Virulent			
17	B10-1	AC	+++	++	0	+	EST (GB/W67981/W67981)	
18	B12-2	AC	++	+++	+	+	EST (GB/N24729/N24729)	
19	B13-4	AC	+++	++	+	+	EST (GB/N23012/N23012)	
20	B15-2	AC	+++	±	++	±	EST (GB/R49664/R49664)	
21	B17-2	AC	++++	+++	++	+	EST (GB/T34605/T34605)	
22	B18-2	AC	++++	++	+++	+	EST (GB/AA055573/AA055573)	
23	B19-5	AC	+	++	+	±	EST (GB/AA076421/AA076421)	
24	B21-3	AC	+++	+++	+	++	EST (GB/AA150905/AA150905)	
25	IN10-B10	AC	+	+++	+	+++	EST (GB/N21073/N21073)	
26	IN19-E7	AC	0	++++	0	+	EST (GB/AA044087/AA044087)	
27	IN21-E9	AC	+	+++	+	++	EST (GB/H44997/H44997)	
28	IN22-E10	AC	++++	++	+++	+	EST (GB/N50114/N50114)	
29	Bcl	AC	+++	+++	+	++	EST (EMB/Z39133/HSC11B122)	

FIG. 4 (Cont.)

No.	Clones	N1N2	Differential Display			Summary of Results (I)		Gene Bank Search and Analysis		Unknown Sequences
			Control	E. coli	Virulent	A virulent				
1	NP109-5	AA	+++	±	±	±	+	Unknown		
2	NP110-2	AA	±	++	+	++	++	Unknown		
3	NP111-2	AG	++	±	+	+	+	Unknown		
4	NP112-1	AG	0	0	0	++	++	Unknown		
5	NP118-1	AG	+++	+	+++	+	+	Unknown		
6	NP129-3	CA	±	+	+	++	++	Unknown		
7	NP137-1	CC	0	+	0	++	++	Unknown		
8	NP140-1	CC	±	++	±	++	++	Unknown		
9	NP143-3	CC	+	++	++	±	±	Unknown		
10	P144-1	CC	+	++++	+	++++	++++	Unknown		
11	NP146-2	CC	++	++++	+++	+++	+++	Unknown		
12	NP157-1	CT	0	+	+	++	++	Unknown		

FIG. 4 (Cont.)

BamH1 gel1.JPG

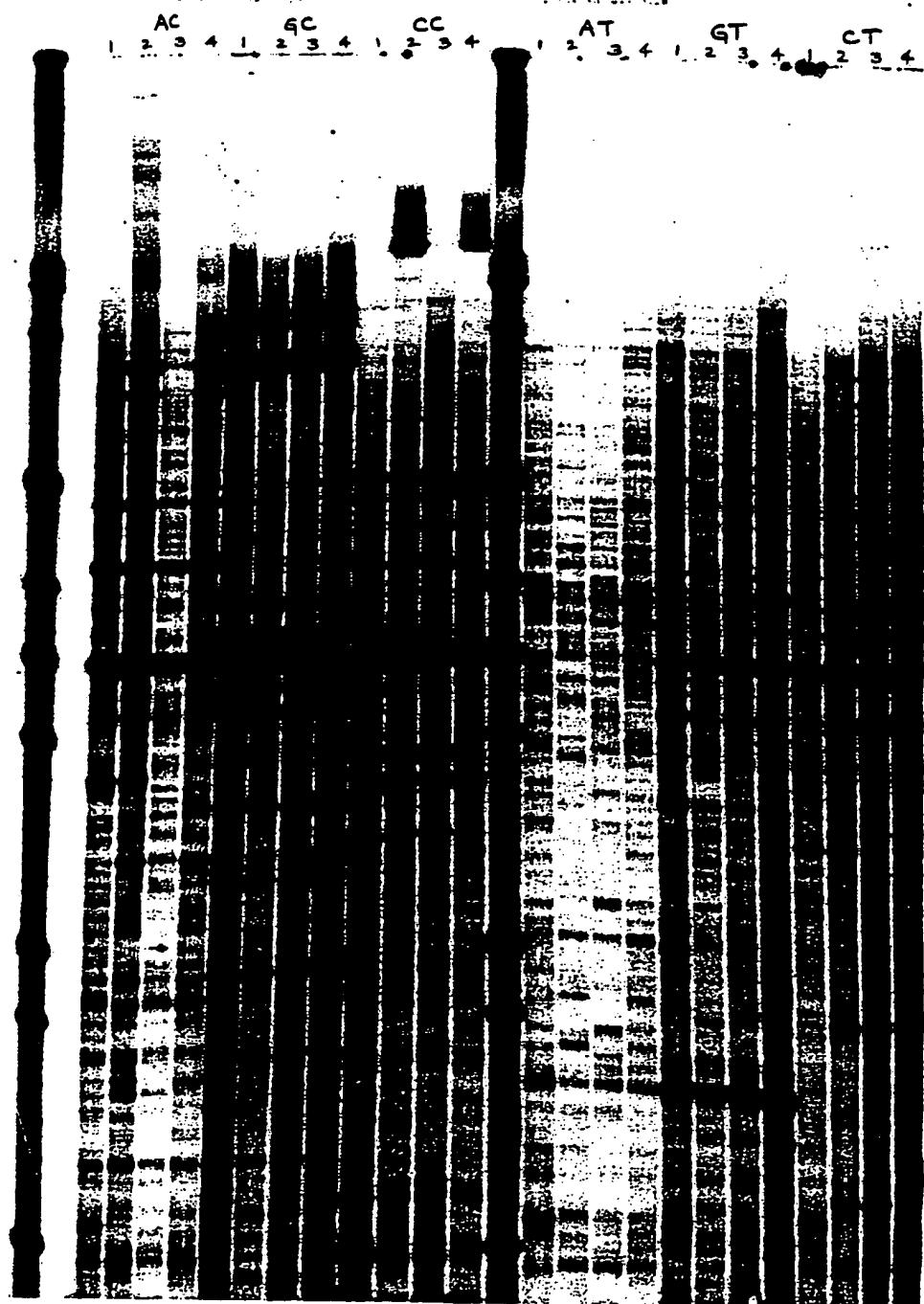


FIG. 5

BamH1gel2.JPG

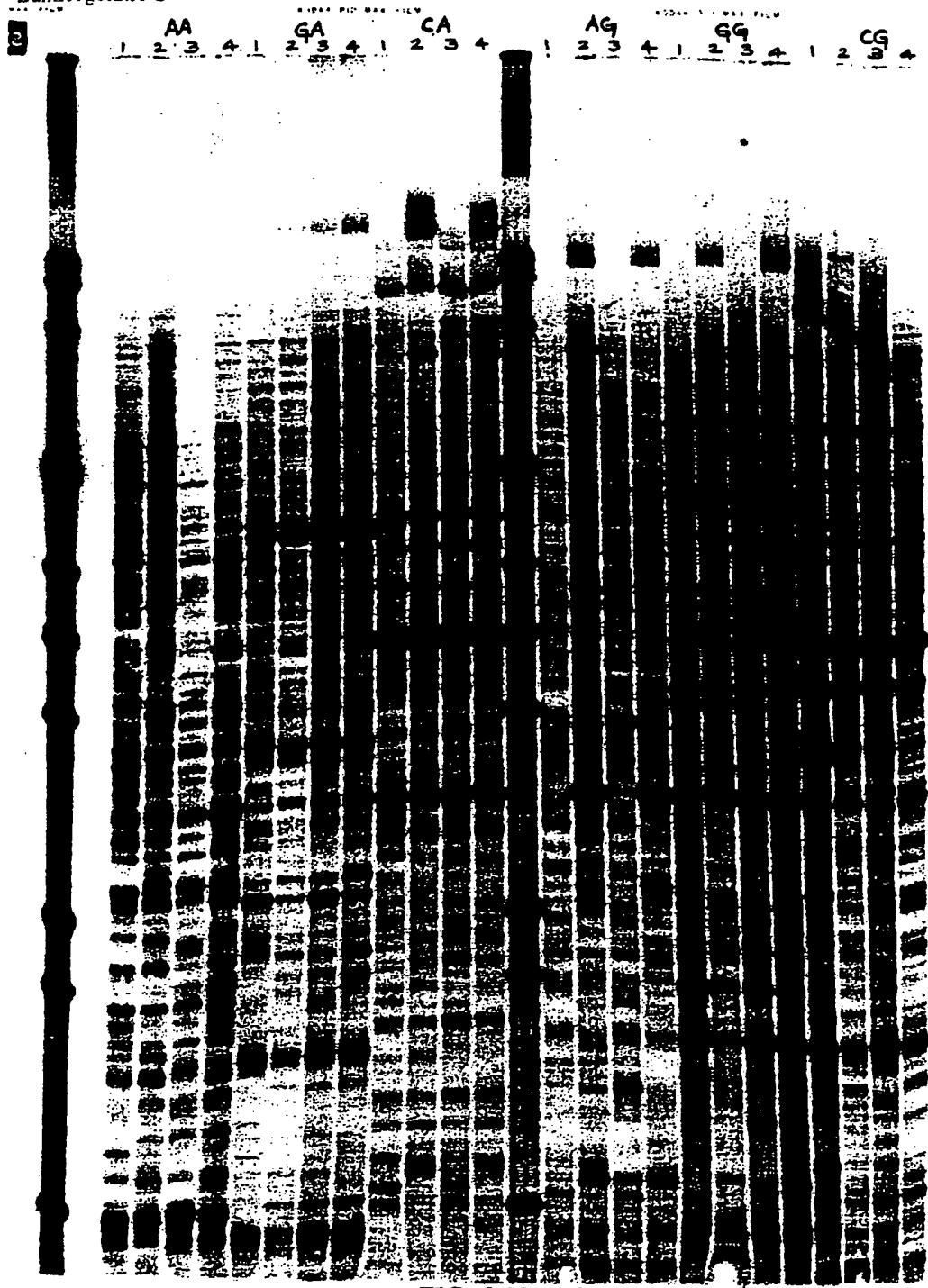
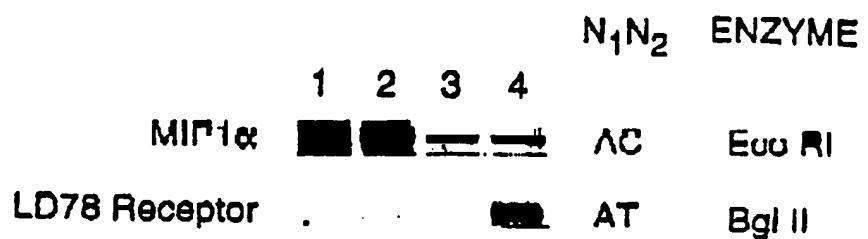


FIG. 5 (Cont.)



1. Neutrophils alone
2. Neutrophils + *E.coli*
3. Neutrophils + Virulent *y. pestis*
3. Neutrophils + Avirulent *y. pestis*

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/17284

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C12Q 1/68; C07H 21/04; C12P 19/34
US CL :435/6, 91.2; 536/24.2

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 435/6, 91.2; 536/24.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97/05286 A1 (YALE UNIVERSITY) 13 February 1997, see entire document.	1-13
Y	TAM, F.W.K., et al., Differential expression of macrophage inflammatory protein-2 and monocyte chemoattractant protein-1 in experimental glomerulonephritis. Kidney Internat. 1996, Vol. 49, pages 715-721, see especially the abstract, page 716, col. 1, and Figure 1.	1-13

Further documents are listed in the continuation of Box C.

See patent family annex.

Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"A"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

10 NOVEMBER 1998

Date of mailing of the international search report

22 DEC 1998

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/17284

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

MEDLINE, SCISEARCH, CANCERLIT, BIOSIS, EMBASE, WPIDS, USPATFULL, APS
search terms: glomerulonephritis, neutrophil, polymorphonucleocyte, granulocyte, bacteria, virus, fungus, parasite, gene, DNA, nucleic acid, inflammation, gene expression